APPENDIX A

2024 San Joaquin River Basin, Lower San Joaquin River, California Project, Compensatory Mitigation Plan

San Joaquin River Basin, Lower San Joaquin River, California Project
Compensatory Mitigation Plan

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List of Acronyms

AAHU	Average Annual Habitat Units
ASA(CW)	Assistant Secretary of the Army for Civil Works
BCOES	Biddability, Constructability, Operability, Environmental Sustainability
BLM	Bureau of Land Management
CA	California
CalEPA	California Environmental Protection Agency
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
CNGA	California Native Grassland Association
CRAM	California Rapid Assessment Method
CVRWQCB	Central Valley Regional Water Quality Control Board
CY	Cubic Yards
DWR	Department of Water Resources
EFH	Essential Fish Habitat
EPA	United States Environmental Protection Agency
ER	Engineering Regulation
ESA	Endangered Species Act
GC	Grams of Carbon
GGS	Giant Garter Snake
HEP	Habitat Evaluation Procedures
HMAMP	Habitat Monitoring and Adaptive Management Plan
HSI	Habitat Suitability Index
Inc	Incorporated
LLC	Limited Liability Corporation
M	Meter
NFS	Non-Federal Sponsor
NFWF	National Fish and Wildlife Fund
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
PL	Public Law
ppt	Parts per Trillion
RD	Reclamation District
SJCOG	San Joaquin Council of Governments
SOM	Soil Organic Matter
SRA	Shaded Riverine Aquatic
TS-30L	Tenmile Slough mile 30 left bank
USACE	United States Army Corps of Engineers
USC	United States Code
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Service
VELB	Valley Elderberry Longhorn Beetle
WRDA	Water Resources Development Act

1. Overview

The San Joaquin River Basin, Lower San Joaquin River, California Project (LSJR Project), was authorized by section 1401(2) of the Water Resources Development Act (WRDA) of 2018 (Public Law [PL] 115-270). Funding was provided under Division D, Title I of the Consolidated Appropriations Act of 2021 (PL 116-260). The purpose of the project is to reduce flood risk by reducing the risks associated with seepage, stability, overtopping, and erosion for the levees along the San Joaquin River, Calaveras River, Fourteen-mile Slough, Tenmile Slough (TS), French Camp Slough, Mosher Slough, and Duck Creek. This document presents the compensatory mitigation plan for unavoidable habitat impacts associated with the Lower San Joaquin River Project. This plan addresses only compensatory mitigation work and not the sequence of other activities performed during project planning to avoid, minimize, rectify, or reduce habitat impacts from each project option (see Engineer Regulation [ER] 1105-2-100, Appendix C, Section C-3(b)(12)). Details of the project planning actions to avoid and minimize impacts are included in the plan formulation and environmental consequences sections of the *San Joaquin River Basin, Lower San Joaquin River, CA, Final Integrated Interim Feasibility Report/ Environmental Impact Statement/ Environmental Impact Report: January 2018* (2018 LSJR FS/EIS/EIR) (included in this document as Appendix B) and associated environmental compliance documents. This plan assumes those planning actions will be implemented as described in the aforementioned documentation, and they are incorporated into the mitigation objectives of this plan. The planning work performed to document those sequencing actions is generally complete and led the team to the need to develop a compensatory habitat mitigation plan for unavoidable impacts to fish and wildlife resources considered significant under federal standards. However, the primary mitigation measure for state listed resources is avoidance. In most cases, state listed resources can be avoided through survey and modification of how the work is conducted. However, since full and complete survey of all reaches has not been completed, it cannot be guaranteed with absolute certainty that all state listed resources can be avoided. Avoidance measures such as survey and other conservation measures are detailed in applicable National Environmental Policy Act (NEPA) and California Environmental Quality Act (CEQA) documents. This document details the work performed to date, including coordination, plan formulation, and environmental compliance, to develop the compensatory habitat mitigation plan.

2. Authority and Requirements for Mitigation

The purpose of this document is to provide information to support decision making pertaining to compensatory mitigation. Some detailed information has yet to be developed. Additional detailed information will be available in individual environmental survey and compliance documents for proposed mitigation projects.

The authority and requirements for compensatory mitigation are founded in Federal laws and regulations. The legal foundation for mitigation for ecological resources includes the Clean Water Act, various WRDAs, and other environmental laws. These laws are implemented and administered through rules, guidance, regulations, and policies issued by Executive Branch agencies.

The relevant laws and regulations specific to compensatory mitigation planning for U.S. Army Corps of Engineers (USACE) civil works projects are listed in the References section of this document. The specific procedures followed to develop this compensatory habitat mitigation plan are found in ER 1105-2-100, Appendix C. Other forms of mitigation, such as plans for cultural resources conservation or induced flood damages, may also be required for a project. Those types of mitigation requirements are not directly related to fish and wildlife habitat impacts and are not covered in this plan.
Compensatory mitigation is the "restoration (re-establishment or rehabilitation), establishment,

enhancement, and/or in certain circumstances preservation of aquatic resources for the purposes of offsetting unavoidable adverse impacts which remain after all appropriate and practicable avoidance and minimization has been achieved" (see 40 CFR 230.92). It is the policy of the USACE civil works program, and in accordance with Section 906 of WRDA 1986 (PL 99-662), as amended, to demonstrate that impacts to all significant ecological resources, both terrestrial and aquatic, have been avoided and minimized to the extent practicable, and that compensation is provided for any remaining unavoidable impacts.

Compensatory mitigation plans are normally included as a part of the draft and final feasibility report for a project released for public and agency review. The compensatory mitigation plan included in Appendix D- Environmental- Part 3- Addendum J of the (2018 LSJR FS/EIS/EIR) primarily relied on mitigation bank credits to compensate for unavoidable impacts to ecological resources, including fish and wildlife. However, a lack of appropriate mitigation bank credit types and quantities needed to fulfill the project's compensatory mitigation and project schedule requirements made credit purchase options infeasible. Nonetheless, despite lack of compensatory credits in available banks, USACE will continue to monitor and purchase any available credits in compliance with the original plan. This plan is a supplement to the plan published with the feasibility report.

Credit availability and outlook updates will be provided quarterly during each quarter of each fiscal year at the on-going mitigation and PDT meetings for the LSJR Project.

Based on comments received from the U.S. Fish and Wildlife Service (USFWS) during the public review of the 2018 LSJR FS/EIS/EIR, USACE also agreed to investigate additional opportunities to implement cost effective, feasible, and acceptable compensatory mitigation on site, and near the project sites, in addition to offsite opportunities, during project engineering and design.

This document should be considered a living document with future revisions expected. Mitigation needs could increase if avoidance and minimization actions are not implemented as planned. Mitigation needs may be reduced if further avoidance and minimization actions are incorporated during project level design. Mitigation opportunities could change if target properties become unavailable, credit availability changes, or if anticipated habitat impacts change. Any of these changes in conditions could warrant a revision to the Recommended Plan. The purpose of this plan is to present a realistic and cost-effective path to satisfy compensatory mitigation needs as they are currently understood.

3. Coordination and Collaboration

Development of this plan involved coordination and collaboration with the project's non-federal sponsors (NFS), the San Joaquin Area Flood Control Agency and the Central Valley Flood Protection Board, in coordination with the California Department of Water Resources (DWR). Public input was initially sought during interagency meetings, public scoping meetings, and during review of the 2018 LSJR FS/EIS/EIR and associated environmental compliance documents. Additional public input will be solicited during the public review phase for the environmental documents associated with this plan and future segments of the LSJR Project. Discussions with area landowners helped characterize local site conditions, gauge opportunities for potential mitigation work in these areas, and defined support for mitigation at potential site locations.

An interagency team, including representatives from USFWS, National Marine Fisheries Service (NMFS), California Department of Fish and Wildlife (CDFW), and Environmental Protection Agency (EPA), in addition to the NFS/USACE team, met throughout the feasibility study and regular coordination meetings were held during the formulation of this draft plan to solicit input. Resource agencies contributed expertise and information to support the identification of impacts and the development of compensatory mitigation plan options. The views of resource agencies, including the USFWS and NMFS, and others were considered in the development of this draft plan. Additional organizations will be offered an opportunity to review and comment on the plan during the NEPA/CEQA public review period. The interagency team will continue to play a role in the mitigation design and implementation phases of the mitigation work for individual for the LSJR Project phases, segments, and mitigation sites through recurring meetings and review of documents.

4. *Ecological Resources*

The LSJR Project is in the San Joaquin Basin. The urban core of Stockton is already heavily developed with little remaining habitat. The remainder of the basin is characterized as largely agricultural (United States Geological Service [USGS], 2012) with a rapidly urbanizing population (San Joaquin Council of Governments [SJCOG], 2017). The San Joaquin Basin consists of the San Joaquin River and its tributaries— the Cosumnes, Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, and Fresno Rivers, which join the San Joaquin from the east and flow out to the tidally influence Sacramento-San Joaquin Delta in the west (Central Valley Regional Water Quality Control Board [CVRWQCB], 2019). Most of the flow in this basin below the headwaters has been highly modified via a system of dams, levees, and canals to support the region's agricultural economy (CVRWQCB, 2019). Historically, the region supported runs of salmon; however, construction of dams has resulted in the species' extirpation in much of their historic range (Chamberlin, 2022). The region likely consisted of a patchy mosaic of oak woodland savannah to the east, transitioning into non-tidal freshwater emergent wetlands with tidal freshwater emergent wetlands to the west (Whipple et. al., 2012).

Existing habitat was catalogued during the feasibility study. Since detailed habitat assessments will be conducted on a reach-by-reach basis prior to construction, the estimates of existing habitat from the feasibility study have been used to inform the compensatory mitigation strategy effort, as the level of detail in the feasibility study is sufficient to inform decision making. During feasibility, USACE investigated the habitat resources found in the project area. The team collected information from existing data sources, such as the ECOS-IPAC[1] database, the CNDDB[2] database, official species list, and conducted field visits and surveys. Other sources of habitat data included information from resource agencies, published reports, agency records, and field investigations.

The project area includes giant garter snake (GGS; *Thamnophis gigas*) upland and aquatic habitat, shaded riverine aquatic (SRA) habitat, riparian woodland, Valley Elderberry Longhorn Beetle (VELB; *Desmocerus californicus dimorphus*) habitat, shallow water habitat, open water habitat, wetlands, and grasslands. SRA habitat in the project area supports the California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*), and the Southern distinct population segment (sDPS) of North American green sturgeon (*Acipenser medirostris*) and overlaps with federally designated critical habitat for these species. Effects from implementation of and long-term operations of the project are anticipated to affect the Central Valley (CV) spring run Chinook salmon (*Oncorhynchus tshawytscha*), however, there is no designated critical habitat for the CV spring run Chinook salmon in the project area (NMFS, 2016). Shallow water and open water habitat in the project area may support Delta Smelt, green sturgeon, and steelhead. Specifically, habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead smolts and for adult freshwater migration, no spawning of CCV steelhead occurs within the project area and estuarine habitats are further

[1] ECOS-IPAC- Environmental Conservation Online System- Information for Planning and Consultation

[2] CNDDB- California National Diversity Database

downstream (NMFS, 2016). All life stages of the SDPS of green sturgeon may utilize any of the riverine habitats within the project area. Table 1 shows the habitat resources in the project area, the quantity of the resource, the type of impact to the resource, and the significance of the resource. These resources are recognized as significant across institutional, public, and technical perspectives. The 2018 feasibility report discusses these three significance factors in detail. Table 1 summarizes the resource significance from a qualitative perspective based upon the interagency team's assessment. Significance assessments assist teams in understanding the ecosystem impacts of the project and the linkages of the resources to other parts of the system or watershed. Habitat quantities were largely estimated using aerial imagery. Impacts were estimated based on expected project design footprints. However, specific quantities of affected and the precise area of habitat impacts is subject to change based on site design refinements.

During the course of design and construction of the LSJR Project, detailed habitat surveys will be conducted on a site-by-site basis in both impact areas as well as proposed mitigation sites. These surveys will identify the baseline ecological condition, significant existing resources that should be avoided in place, uplift potential, and provide information for determination of appropriate compensation ratios.

Table 1- Summary of Ecological Resources Impacted in the Project Area as Estimated in the 2018 LSJR FS/EIS/EIR

Habitat	Quantity	Type of Impact	Significance of Resource
Giant Garter Snake Aquatic	0.5 acres (permanent)	Removal of vegetation, bank hardening, reshaping of slopes, and altered hydrology	Provides foraging habitat for giant garter snake.
	6 acres (temporary)		
Giant Garter Snake Upland	12.5 acres (permanent)	Direct removal	Provides overwintering habitat and high water refugia for giant garter snake.
	111.5 acres (temporary)		
Riparian	139 acres	Removal of vegetation and bank hardening	Provides habitat for many birds and mammals and provides a food source into the adjacent aquatic ecosystem. Only about 5% of the historic amount of riparian habitat in the Central Valley remains (Warner and Hendrix, 1984).
Elderberry Shrubs	44 Shrubs*, 96 stems	Direct removal	Provides habitat for VELB. Provides a vital food source and nesting space for migratory birds.
Shaded Riverine	19,360 linear feet	Altered water velocities, removal of vegetation, bank hardening	Provides thermoregulation, cover, and a food source to the adjacent aquatic ecosystem.
Delta Smelt Shallow Water	238 acres**	Altered hydrology	Provides primary foraging habitat for endangered Delta Smelt in addition to other species of juvenile fish.
Delta Smelt Open Water	1.52 acres**	Altered hydrology	Provides breeding space and refugia for endangered Delta Smelt. Provides habitat for other fish species and waterfowl.
Wetland	10.75 acres	Direct removal	Provides habitat for numerous migratory birds along the Pacific Flyway. Provides water filtration preventing numerous agricultural chemicals from entering aquatic habitat. Allows for groundwater recharge.
Grassland	8.87 acres	Direct removal	Provides habitat for numerous species at the base of the food chains for other systems.

Notes: ** The feasibility report identified a total of 41 shrubs potentially impacted, however, after site visits and discussions with the USFWS during the formal consultation process, the number of shrubs potentially impacted by the LSJR Project was revised to 44 in the 2016 Biological Opinion. Guidelines for impact assessment to VELB were updated in 2017 and no longer use stem/shrub counts.*

*** Shaded Riverine (nearshore) habitat is utilized by Central Valley (CV) spring-run Chinook salmon, sDPS green sturgeon, and California Central Valley steelhead (CCV steelhead)*

****The feasibility report identified potential impacts to 233 acres of shallow water habitat and 1acres of impacts to open water Delta Smelt habitat, however, design refinements resulted in actual impacts of 238 acres and 1.52 acres, respectively.*

All values are estimates and subject to change based on habitat surveys and levee improvement design refinements.

Giant Garter Snake Aquatic Habitat

The recovery plan for giant garter snake defines aquatic habitat as having slow moving or static water present from March through November with adjacent upland refugia (USFWS, 2017). Preferable habitat contains mud substrates with emergent and bankside vegetation, such as tule (*Scirpus* spp.) clumps, for cover and thermoregulation; however, such vegetation should not form a continuous canopy (USFWS, 2017). Lastly, habitats should have a prey base consisting of small amphibians and fish and have a low incidence of larger predatory fish (USFWS, 2017).

Giant Garter Snake Upland Habitat

While the giant garter snake is primarily an aquatic species, it utilizes upland habitat during the active season for basking, shelter, and to avoid predation (USFWS, 2017). During the inactive winter season, giant garter snakes may spend most of their time in a burrow in a lethargic state (USFWS, 2017). Summer upland habitat is generally within about 50 meters from aquatic foraging habitat (USFWS, 2017). Wintering habitat can be up to 250 meters from aquatic habitat. Upland habitat components include: 1) availability of bankside vegetative cover, typically tule or cattail (*Typha* sp.), for screening from predators; 2) availability of more permanent shelter, such as bankside cracks or crevices, holes, or small mammal burrows; 3) lack of poor grazing management practices (i.e., grazing to the point at which giant garter snake refugia has been reduced or eliminated) (USFWS, 2017).

Riparian Communities

In general, riparian communities are among the richest community types, in terms of structural and biotic diversity, of any plant community found in California. Riparian vegetation provides important ecological functions, including serving as wildlife habitat; providing a migratory corridor for wildlife; filtering out pollutants and shading waterways, thereby improving water quality; providing connectivity between waterways and nearby uplands; providing biomass (nutrients, insects, large woody debris, etc.) to adjacent waterways; and, in some situations, reducing the severity of floods by stabilizing riverbanks. Riparian forests and woodlands even remnant patches are important wildlife resources because they continue to be used by a large variety of wildlife species and because of their regional and statewide scarcity.

The overstory of the riparian habitat consists of mature, well-established trees, such as: Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), boxelder (*Acer negundo* var. *californicum*), Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*). The midstory layer generally consists of smaller trees and shrubs such as: poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), California blackberry (*Rubus ursinus*), and elderberry shrubs (*Sambucus* spp.), the host plant of VELB.

Both shaded riverine aquatic (SRA) habitat and VELB habitat are subsets of the riparian community.

Shaded Riverine Aquatic Habitat

SRA habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. SRA in the LSJR Project area may support steelhead, green sturgeon, and spring-run Chinook during certain times of the year.

Valley Elderberry Longhorn Beetle Habitat

The VELB is completely dependent on its host plant, blue elderberry (*Sambucus Mexicana*), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. Elements of suitable VELB habitat include: 1) elderberry of sufficient size to support larvae (≥2 cm diameter stems); 2) sufficient density of shrubs in a given area to support a population of beetles; 3) sufficient supporting habitat generally adjacent to or within moist, riparian ecosystems; 4) habitat connectivity —free of highways, pesticides, or other barriers (USFWS, 2019).

Shallow Water Habitat

Shallow water habitat in the LSJR Project area may support Delta Smelt, steelhead, and green sturgeon. Delta smelt are endemic to the Sacramento-San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. Delta Smelt shallow water habitat is defined as aquatic areas with a depth of less than 10 feet and a salinity range between 0 and 18.4 parts per trillion (ppt) (USFWS, 1995) with a supply of planktonic food, and ideally sandy substrates (CDFW, 2021). Within the LSJR Project area, open water habitats may serve as freshwater rearing and migration corridors for steelhead. All life stages of green sturgeon could occur within shallow water habitats in the LSJR Project area.

Open Water Habitat

Open water provides breeding, foraging, and migration habitat for numerous wildlife species. Mammal species commonly known to use perennial aquatic open water habitats include river otter, which use these areas for foraging and escape cover, and muskrat, which may use deep water areas as migration corridors between suitable foraging areas. Open water areas also provide essential foraging habitat for wading birds, including great blue heron, great egret, and snowy egret; numerous waterfowl species, including mallard, ruddy duck, and bufflehead; other water birds, including eared grebe, double-crested cormorants, and American white pelicans; and land birds, including black phoebe and belted kingfisher. These areas also provide rearing habitat, escape cover, and foraging habitat for reptiles and amphibians, including common garter snake, bullfrog, Pacific tree frog, and western toad. The vegetated areas below the ordinary high-water mark provide nesting habitat for numerous songbirds, including red-winged blackbird and marsh wren, and wading birds such as Virginia rail.

CCV Steelhead Freshwater Habitat

Shallow and open water habitats, in addition to SRA along bank lines, serve as habitat for CCV Steelhead. In addition to the characteristics listed in the preceding paragraphs, the physical and biological factors which constitute freshwater habitat for CCV steelhead include areas with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging woody material, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks (NMFS, 2016). In general, habitat within the LSJR Project area is understood to be low complexity, with little food, and little cover from other fish or avian predators. These same areas would serve as migration corridors for the species and therefore need to remain free from migratory obstructions and maintain sufficient water quality to allow migration.

Green Sturgeon Freshwater Habitat

Sturgeon utilize a variety of substrate types for spawning, but are primarily associated with clean sand, gravel, cobble, and boulder sized substrates (NMFS, 2018). Juvenile rearing habitat prior to first migration are cool freshwater habitats with abundant macroinvertebrates such as insect larvae, oligochaetes and decapods (NMFS, 2018). Adults return to freshwater habitats several times over their lives and may utilize holding pools which are greater than 5 meters deep with sufficient water quality

(NMFS, 2018).

Wetlands

Wetlands are areas that are inundated or saturated by surface or groundwater at a frequency and duration necessary to support, and under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. For other water features such as rivers, streams, and ditches, the extent of potential Corps USACE jurisdiction is determined by identification of the Ordinary High-Water Mark, which is defined as "that line on shore established by the fluctuations of water and indicated by physical character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (33 CFR 328.3[e]).

Grasslands

Grasslands are generally upland areas dominated by herbaceous vegetation cover with little to no overhead canopy cover. These habitats are generally dominated by common grasses like ripgut brome, foxtail barley, weeds such as yellow starthistle and Italian thistle, and others. It is present on levee slopes and adjacent land side and water side areas throughout the project area that are not rocked, as well as within the upper portions of the Calaveras River and Stockton Diverting Canal floodways, which are dry outside of the flood season. Much of this area is subject to regular mowing as a maintenance and fire control activity, as well as grouting of animal holes. These areas do have wildlife value such as to foraging hawks, and their prey such as the California vole. The FWCA report by USFWS dated July 2016 designated this habitat type as Resource Category 4, which is generally abundant and having a lower relative value than other habitat types, conservation for this Resource Category is to "minimize net losses to habitat value". Since Grassland habitats are common, and many levee sections would be re-seeded following improvement, additional compensation is not anticipated to be needed for the LSJR Project.

Ecological Resources by LSJR Project Reach

Ecological resources were identified on a reach basis during the feasibility phase of the LSJR Project. While these resources will be further defined as preconstruction engineering and design progresses, the below listed habitat descriptions are sufficient to inform decision making as it pertains to mitigation planning. Prior to construction, elderberry surveys, habitat evaluation procedures (HEP) surveys, tree surveys, vegetation surveys and wetland delineation/condition surveys, as appropriate, may be conducted to characterize the ecological baseline of each LSJR Project site.

<u>Mosher Slough</u>

Mosher Slough runs through a highly urbanized area. There is significant Woody riparian vegetation along the western 1/3 of the reach near the confluence with the Shima Tract levees near the I5. It is comprised of typical Valley riparian trees and shrubs. Emergent wetland vegetation, such as tule, rushes (*Juncus* sp.), and sedges (*Cyperus* sp.), occur intermittently at the water's edge. Landside vegetation includes nonnative landscape trees and shrubs as well as natives. Typical wetland vegetation lines some stretches of this reach.

<u>Fourteenmile Slough, Fivemile Slough, Tenmile Slough (Delta Front)</u>

Waterward of the levees, some woody riparian trees and shrubs border these highly engineered waterways. Within some of the sloughs and canals, aquatic weeds cover much of the water surface. Along the edges of the waterways, wetland vegetation is present intermittently. Within Fourteenmile Slough, intertidal vegetation is present on rocky substrate that is exposed during low tides. In Buckley Cove, near the confluence of Tenmile Slough with the Sacramento Deep Water Ship Channel, wetland and subtidal vegetation is present along with aquatic weeds. Landside vegetation is comprised mainly of row crops with some parcels in orchard.

San Joaquin River

On the San Joaquin River, lands on the waterside of the levees are very narrow and support the remnants of a riparian forest. Trees and shrubs occur in small patches or may be scattered individuals. Vegetation on the waterside of levee slopes in the LSJR Project area is highly varied, ranging from ruderal herbaceous vegetation and annual grasses with few shrubs, to dense shrubs with little overstory, to mature riparian forest. Potential SRA habitat cover is found along much of the river in the LSJR Project area. Dominant waterside tree species include cottonwood, willow, oak, boxelder, and black walnut (*Juglans* sp.). In the LSJR Project area, common shrub species include willow, wild rose, and blackberry. Elderberry shrubs are also present in some locations. Early successional herbaceous vegetation is present on levee slopes. In some places the tree overstory along the levee is so dense that the leaf fall and shading, as well as human activity, precludes development of dense understory vegetation. At Dos Reis Road there is a park on both sides of the levee. Vegetation includes willows, weeping willow (*Salix babylonica*), cottonwood, fruitless mulberry (*Morus alba*), mesquite elderberry, and mistletoe (*Phoradendron* sp.).

Landside levee slopes are primarily barren or covered with ruderal vegetation. Beyond the base of the levees, riparian vegetation is rare but occasionally present in small, isolated patches. Other trees include occasional single or isolated stands of native oaks and nonnative trees planted around farms, agricultural fields, and residential or other types of development. Larger remnant patches of Great Valley cottonwood riparian forest located within the study area are dominated by large Fremont cottonwood, trees and Goodding's willow (AECOM, 2011). Most of the otherwise linear or smaller patchy areas of this community lack Fremont cottonwood and are represented by Gooding's willow, red willow (*Salix laevigata)*, arroyo willow (*Salix lasiolepis*), sandbar willow, and scattered valley oak, Oregon ash, and buttonbush (*Cephalanthus occidentalis*) (AECOM, 2011). Native ground cover, mainly found in the larger remnant patches of riparian forest, include California blackberry and wild rose. Common nonnative understory species found in most elements include Himalayan blackberry (*Rubus armeniacus*) and tree tobacco (*Nicotiana glauca*). Most of the Great Valley cottonwood riparian forest community could also be characterized as Great Valley riparian scrub, which does not include Fremont cottonwood and is characterized by a shorter canopy and more uniform structure; however, this habitat is part of the Great Valley cottonwood riparian forest that was extensive and connected along this entire reach of the San Joaquin River, and this document therefore describes all riparian habitat as such (AECOM, 2011).

Calaveras River

Levees and the lands adjacent to both the waterside and landside of the levees in the reach of the Calaveras River above, and just below, the Stockton Diverting Canal are largely devoid of trees and shrubs. The exception is some orchards landward of the north levee. Moving downstream, more trees and shrubs are present on and adjacent to the levees. In the highly urbanized reaches, many of the landside trees and shrubs are associated with landscape plantings in yards, parks, and public rights of way. Wetland vegetation appears to line the channel in places.

Smith Canal

Smith Canal is surrounded by urban residential areas, including hard-scaping (sidewalks) and some landscape plantings adjacent to the water's edge. Near the confluence of the canal with the San Joaquin River, there is a public park, including a picnic area, boat launch ramp and associated infrastructure. There is an irrigated lawn and a mixture of native and non-native trees and shrubs. Wetland vegetation is prevalent at the water's edge and non-native invasive water plants inhabit the "bay" near the boat launch ramp. Invasive waterweeds, including water hyacinth (*Pontederia crassipes*), occupy much of the inlet in the vicinity of the boat launch ramp.

Work on the Smith Canal segment, including any needed mitigation, commenced in July of 2020, and is on-going. Consultation for the segment under the Endangered Species Act (ESA) was reinitiated in June of 2016 and amended biological opinions were issued August 18, 2019, and May 18, 2023. The most recent amended biological opinion revised shallow water habitat impacts to 0.82 acres from the gate, reduction in habitat quality affecting 0.39 acres due to rock slope protection, and open water habitat to 68 acres. Mitigation required under the amended biological opinions are discussed in Section 5 of this Mitigation Plan.

French Camp Slough and Duck Creek

Levees along Duck Creek are clear of trees and shrubs. Adjacent lands are largely in agriculture with urban development beginning to extend into these lands. French Camp Slough upstream of the confluence with Duck Creek is very similar in character to Duck Creek. Levees are free of trees and shrubs and adjacent lands are in agriculture with urban lands extending towards the levee slough. The lower reaches of French Camp Slough (between Duck Creek and the San Joaquin River) are surrounded landward by urban development. The Weston Ranch residential development is immediately to the south in the northern portion of Reclamation District (RD) 17 (Mossdale Tract). A municipal golf course extends adjacent to the northern bank/levee of French Camp Slough in Central Stockton. Between the north and south French Camp Slough levees is an "island" of land that is in agriculture. The perimeter of this island contains a fairly thick margin of trees and shrubs.

In the lower French Camp Slough reach, the levee crown includes a paved road. The landside levee slope and toe are mostly devoid of vegetation. There are some annual grasses and herbs. These are largely non-native weedy plants. Where trees and shrubs are present within the landside easement, they are mainly landscape plantings associated with public rights of way and private yards. The waterside levee slope and easement have trees and shrubs throughout their length, being quite dense in some areas. Trees include native valley oak, box elder, cottonwood, black walnut, and willows. Elderberry shrubs, poison oak, patches of dead willow shrubs, and snags are present. In the canal between the RD 17 levee and the mid-channel island to the north, wetland plants are abundant. These include tules, nut sedges (*Cyperus* sp.), and tule potato (*Sagittaria* sp.). Non-native English walnut trees, water hyacinth, and mistletoe are also present.

5. Significant Net Losses

Based upon the type(s) of habitat(s) in the LSJR Project area, the interagency team determined that Habitat Evaluation Procedures (HEP) method would be an appropriate tool to assess the LSJR Project's impacts on fish and wildlife habitat and other ecological resources. A combination of three "blue book" Habitat Suitability Index (HSI) models approved by the Corps USACE Ecosystem Planning Center of Expertise were used to best approximate the different habitat types in the study area. However, HSI models used, and the results of the modeling analysis, were not coordinated with USFWS at the time of publication of the 2018 LSJR FS/EIS/EIR. Model outputs are an index value from 0.0 to 1.0 for a representative species, with zero representing least favorable conditions and one representing most favorable conditions. The product of the HSI and the habitat quantity in acres yields habitat value units which are expressed over the period of analysis resulting in Average Annual Habitat Units (AAHUs). Since detailed data is not currently available for all reaches, a HEP analysis will be performed on a reach-by-reach basis as designs progress to refine mitigation requirements, as agreed. Consistent with this process, values for Tenmile Slough, mile 30, left bank, (TS-30L) have been updated and are shown in Table 2 below. Habitat impacts, and required compensation, for ESA listed species are established in the biological opinions issued by the USFWS and the NMFS. Individual segments of the LSJR Project are grouped into units by geographical proximity, known as reaches, to provide a general understanding of where an impact will occur. Future design work will further refine the locations. Table 2 displays the anticipated habitat impacts by LSJR Project reach. Note that Table 2 does not include temporary impacts which are anticipated to last a single construction season. Values for SRA habitat were developed with the assumption that temporary impacts to SRA could be reduced through obtaining a design deviation that would allow approximately 25-50 percent of existing waterside vegetation to remain, as an exception to current USACE policy (EP 1110-2-118) at the time of the feasibility study. However, if retention of waterside vegetation is not achievable, a total of 34,562 linear feet of SRA habitat would be directly impacted by the LSJR Project. Determinations as to whether or not vegetation can be safely integrated or retained in LSJR Project designs, will be made during the specific design phase for each segment. For TS-30L, a design deviation will not be sought as all vegetation will be removed to accommodate reshaping the levee (USACE, 2021).

Table 2- Net Habitat Losses for the LSJR Project by Reach

	GGS Upland (acres)	GGS Aquatic (acres)	SRA (LF)	Elderberry (shrubs)	Delta Smelt Shallow Water (acres)	Open Water (acres)	Riparian (acres)	Wetland (acres)	Grassland (acres)
TS-30L	Breakdown not available	Breakdown not available	0	6	0	0	13.88	0.6	Breakdown not available
Mosher Slough			0	0	0	0	21.5	3	
Delta Front			0	0	238	1	20.75	2.4	
Calaveras River			7804	5	0	0	52	1.75	
San Joaquin River			6317	33	0	1	17	0	
French Camp Slough			5509	0	0	0	15.75	0	
Duck Creek			0	0	0	0	2	2	
Total	**12.5**	**0.5**	**19630**	**44**	**238**	**4**	**139**	**10.75**	**8.87**

Table 3 displays the model output results for each of the impacted habitat types. The impacts are quantified using AAHUs. Additional details on the use of the model and the results of the analysis are presented in Appendix D- Environmental- Part 3- Addendum J of the feasibility report in the *Habitat Mitigation, Monitoring, and Adaptive Management Plan* produced by the USACE in 2018 (Appendix B) and in the Fish and Wildlife Coordination Act Report (CAR) issued by the USFWS in 2016 (Appendix C). Since the exact condition of the habitat being impacted was unknown at the time of the feasibility report, and since the timing of mitigation compensation relative to habitat impact remains unknown, the amount of habitat that will need to be replaced can only be accurately reflected as a range. Table 3 shows the habitat units required for mitigation estimated during feasibility in column 3, and column 4 shows the worst-case scenario of high-quality habitat adversely affected with mitigation constructed concurrent with impact to that habitat. Column 4 values were derived from a supplemental CAR prepared by the USFWS and delivered to USACE in November 2022 in support of the TS-30L segment.

Table 3- Total Unavoidable Fish and Wildlife Habitat Impacts for the overall LSJR Project

Habitat Type	Quantity (acres or other)	Quantity (habitat units)	Quantity (acres or other) Assumed at 3:1 Ratio
Riparian	139 acres	72.13 AAHU	417 acres
Wetland	10.75 acres	7.68 AAHU	32.25 acres
Grassland	8.87 acres	0[1] AAHU	0 acres

Note 1- HEP analysis resulted in creation of a net excess AAHU of this habitat type, since most levees would be re-seeded with grasses following levee improvement. Therefore, additional compensatory mitigation for this habitat type is not anticipated to be necessary.

Note 2- Assumed acreages come from assuming a 3:1 mitigation ratio

For mitigation constructed concurrent with habitat impacts, the worst-case scenario, the ratio recommended for on-site mitigation was 2.11 acres to each acre impacted to account for temporal impacts (Table 4).

Table 4- TS-30L Habitat Impacts and Mitigation Needs HEP Evaluation

Habitat Value change, AAHUs				Area to Offset loss		Effective Mitigation Ratio	
				AAHU	acres		
start scenario:		concurrent	10 yr	concurrent	10 yr	concurrent	10 yr
site:	Impact	Mitigation	Mitigation				
Model:	TS_30_L	10ac	10ac				
Yell. Warbler	-8.8	5.9	6.7	14.9	13.1	1.08	0.94
Rip. Songbird	-8.8	3.0	3.1	29.3	28.4	2.11	2.05
Rip. Forest CT	-10.0	5.4	5.7	18.8	17.7	1.35	1.28
Downy Wood.	-3.2	1.4	1.5	22.2	20.8	1.60	1.50
Hairy Wood.	-0.9	0.9	1.3	9.2	6.8	0.88	9

Impact is loss of December 2021 baseline. Mitigation is for a conceptual 10 acre (ac) site started either concurrent with construction or 10 years before construction ("10 yr"), under worst case futures scenario.
Source: Adapted from Supplemental Fish and Wildlife Coordination Act Report for the Lower San Joaquin River Feasibility Study - Segment TS_30_L Habitat Evaluation Procedures, USFWS, November 2022.

Proposed mitigation ratios for some of the proposed mitigation sites were also provided. In general, the further the mitigation site was from the impact, the higher the ratio, as the energy cost to an individual would be higher to reach the mitigation site, and the likelihood of benefit to species would be lower, as the odds of a listed species finding the site is reduced (Table 5).

Table 5- Recommended Mitigation Ratios per Parcel from the Supplemental FWCA Report

Mitigation Site Name	Parcel Size (acres)	Distance from TS-30L	Recommended Ratio (multiplier)
Adjacent Corridor	25 acres	On-site	2.11 : 1
Manteca	170 acres	18 miles	3 : 1 (minimum)
Van Buskirk	50 acres	5 miles	2 : 1 (setback); 2.5 : 1 (without setback)
Olive Orchard	42.6 acres	1 mile	2.5 : 1
Longitudinal Parcel	50 acres	1 mile	2.5 : 1
14-mile pumpstation	114.39 acres	1 mile	2.5 : 1

Notes: The adjacent corridor parcel listed here is essentially on-site mitigation for TS-30L, because no additional habitat units could be created in support of other projects with the larger LSJR Project, and because mitigation for TS-30L will have commenced by the time this plan is finalized, it is not included for analysis in this plan. The purpose of this table is show the range of mitigation ratios as they relate to distance from the impact area.

The USFWS and the NMFS determine acceptable compensation ratios for unavoidable adverse impacts to listed species and their habitat through the Section 7 consultation process. These ratios are based on the timing of the compensation, the quality of the habitat being removed, the quality of the habitat being created, the time required for any compensatory habitat to reach in-kind replacement value of the habitat lost, and the time required for species to likely occupy the habitat. Therefore, habitats which acquire value quickly, such as grasslands, often have a lower compensation value than those which require more time to develop needed primary constituent elements, such as mature woody vegetation with cavities, or riparian systems with downed woody material and standing snags. While biological opinions were received for the feasibility phase of the LSJR Project, a number of significant changes to the LSJR Project description were proposed for the TS-30L portion of the project. Key changes include:

- Restructuring of the LSJR Project sequence, wherein impacts occur immediately following physical completion of mitigation (construction plus all plantings).
- Inability to obtain a design deviation for some segments, which would have allowed the retention of 25-50% of the lower waterside riparian vegetation.
- Inability to obtain bank credits for LSJR Project impacts; bank credits are often afforded a lower mitigation ratio (e.g., 1:1 in-lieu of 3:1) since the habitat for which the credit is sold is already in existence and functioning prior to the habitat impact.

USACE reinitiated consultation with USFWS and received an amended biological opinion on October 6, 2023. The changes resulted in changes to compensation ratios for the TS-30L segment in addition to additional terms, conditions, and conservation measures. Based on this experience, changes to mitigation ratios from the original biological opinion can reasonably be expected. Accordingly, a review of biological opinions issued over the last 10 years for the relevant species in the watershed was conducted to determine average mitigation ratios to provide a range for possible compensation needs (Table 6). Mitigation ratios for this LSJR Project could be lower than the values presented in Table 6, based on the quality of habitat in the affected LSJR Project reaches and the durations of effects, but are unlikely to be higher. While the mitigation ratios are unlikely to be higher, affected acreages could be higher or lower, depending on final LSJR Project designs and assessment of the habitat within and surrounding the LSJR Project area. Nonetheless, the resulting acres required presented in Table 6 are conservative estimates which can be used effectively for mitigation planning purposes.

Table 6- Average Mitigation Ratios Found in Recent Biological Opinions

Species	Acres of Habitat Impacted		Average Mitigation Ratio[2]	Resulting Acres Required
Giant Garter Snake	Aquatic	0.5 acres	3:1	1.5 acres
	Upland	12.5 acres	1:1 per existing BO	12.5 acres*
	Temporary	111.5 acres**	0.5:1	55.75 acres**
	Long term O&M[1]	37.7 acres	3:1 X 0.2 (quality reduction factor)	22.62 credits[1]
Delta Smelt	Shallow Water	238 acres	N/A- per existing BO	19.1 credits/ acres remaining
	Open Water	1.52 acres	3:1	4.56 acres
NMFS Listed Fish (SRA)	19,630 linear feet		3:1	58,890 – 103,686 linear feet***

Note. The current USFWS Biological Opinion uses a 1:1 ratio for compensation for upland GGS habitat. **The USFWS Biological Opinion received during feasibility stated that if temporary effects lasted a single construction season, no mitigation would be required. For NMFS species, "impacts to critical habitat related to construction equipment traffic and construction activities are expected to be temporary and result in no permanent damage to the PBFs of the designated critical habitat (NMFS, 2016)." Permanent losses to habitat were those that changed the hydraulic condition of the surrounding area (e.g., riprap, loss of vegetation without replacement etc.). ***The precise amount of SRA habitat to support NMFS listed species depends on the amount of habitat actually impacted, which will depend on how much waterside vegetation can be avoided. (1) Long term O&M credits have already been purchased and will not be discussed further in this document. (2) Average mitigation ratios were determined by taking the mitigation ratio for each listed species from the last 5 years of biological opinions available on the ECOS_IPAC website and using the mean ratio rounded to the nearest whole number. This value was used unless stipulated "per existing BO".*

The USFWS issued an amended biological opinion for the LSJR Project on May 18, 2023, which revised the mitigation required for Delta Smelt as a consequence of operation of the closure structures at Smith Canal and Fourteenmile Slough.

- to offset the permanent impacts of complete loss of shallow water habitat, due to construction of the two closures structures by purchase of credits at a Service-approved conservation bank at a ratio of 3:1 (credits : acres of impact). For the Smith Canal gate, those impacts have been determined to be 0.82 acre, so the credit purchase will be 2.46 acres. Also, for Smith Canal gate, the Corps has identified a degradation of shallow water habitat quality associated with placement of 0.39 acre of RSP in the vicinity of the miter gate. For this loss, the Corps proposes to apply a 3:1 ratio and purchase an additional 1.16 credits. The area of the Fourteenmile Slough gate impact is estimated to be 0.7 acre, so the credit purchase will be 2.1 acres.

- to offset the permanent impacts of partial loss of shallow water habitat function within an estimated 68 acres in Smith Canal and 170 acres in Fourteenmile Slough, due to operation of the closure structures on tidal action and habitat access with: (a) for Smith Canal – purchase of 5 credits at a Service-approved conservation bank, and water hyacinth control within 4.6 acres east of the gate to maintain <20% coverage, and (b) for Fourteenmile Slough – purchase of 17 credits (acres) at a Service-approved conservation bank.

Since mitigation credit purchases for Smith Canal have been completed, they will not be discussed further. Remaining impacts to Delta Smelt are for Fourteen Mile Slough gate only.

Impacts to elderberry and compensation for impacts to elderberry the stem size of the affected elderberry shrub, whether or not the shrub has been used by VELB in the past as evidenced by exit holes, and whether or not the shrub is in a riparian area. A full accounting of shrubs was not completed, rather the number of shrubs and stems was estimated based on aerial imagery and the abundance of elderberry shrubs in nearby areas (USACE, 2015). "The ratio derived from the existing survey results indicated that 0.7 shrubs potentially occur per mile on the riparian side and 1.6 shrubs potentially occur per mile on the non-riparian side (2.3 shrubs per mile) (USACE, 2015)." In 2017 the USFWS issued the *Framework for Assessing Impacts* to *the Valley Elderberry Longhorn Beetle* habitat assessment guidance which considers the proximity of elderberry shrubs to the project area and whether the shrubs exist in riparian or non-riparian habitat, in lieu of stem counts. Given the change in guidance and the fact that elderberry presence and abundance was estimated during feasibility, rather than based on actual survey data, for the purposes of this plan, VELB habitat will be assumed to be any riparian habitat above the ordinary high-water mark with elderberry shrubs within 165 feet of or within the LSJR Project area, as summarized in Table 7.

Table 7- Estimated habitat impacts and associated compensation acres for VELB

Species	Acres of Habitat Impacted		Mitigation Ratio from 2017 Guidance	Resulting Acres Required
Valley elderberry longhorn beetle	Riparian	134.5*	3:1	403.5**
	Non-riparian	0	1:1	0

*Notes: * Estimate was derived by multiplying the estimated SRA impacts by 10, to assume that area that was below the OHWM and unsuitable for elderberry. The value was then converted to acres.*

***The total acreage presented in this cell is likely an overestimate. However, for planning purposes it sets an upper limit. Prior to construction of sites, habitat surveys including those for elderberry would be conducted.*

Table 8 presents additional information characterizing the significance of the resources from a national, regional, and state perspective. The interagency assessment of LSJR Project impacts determined that the habitat resources in the LSJR Project area are significant. This determination is based upon the factors of significance and the magnitude of unavoidable LSJR Project impacts.

Table 8- Ecological Resource Significance

Habitat Type	Significance – Is the Resource Scarce or Unique at Various Levels?		
	National	Regional	State
Riparian	Nationally, riparian ecosystems provide a disproportionate amount of ecosystems services relative to their landmass (Baker et. al., 2006). Riparian systems in the U.S. "provide habitat for up to one-third of all plant species" (Svejcar, 1997). (Svejcar, 1997). Of the historic 70 to 100 million acres that once existed, only about 25 to 35 million acres of riparian habitats remain in the U.S. (Swift, 1984). Despite the protections that have been afforded to these ecosystems, the spatial extent of these areas still declined, with much of these lands converted to grassland, shrubland, agricultural, or urban lands from 1972 through 2003 (Jones et. al., 2010).	Within the western U.S., riparian ecosystems play an outsized role due to the seasonal aridity of the region. About 60% of all vertebrate species (Omhart and Anderson, 1982) and 70% of all threatened and endangered species (Johnson, 1989) depend on riparian ecosystems in the arid west. Prior to the 1980's, grazing was the primary threat to these ecosystems; however, currently, water management operations including dams and levees, in addition to climate changes and invasive species are the greatest threats to these systems (Poff et.al., 2011).	There are essentially no pristine riparian habitats remaining in California (Warner and Hendrix, 1984). About 5-10% of California's historic riparian habitat remains, most of it in a degraded state (Warner and Hendrix, 1984). Despite this, riparian zones are of enormous value to the health of the environment, providing for groundwater recharge, habitat for as many as 90 percent of the state's birds, storage of carbon, and nutrient cycling (BLM, 2022). With the onset of climate change, riparian habitats provide important thermal refugia (Seavy et. al., 2009) elevating their importance in California even higher.
Wetland	Overall, various estuarine wetlands makeup only 5% of the total amount of wetlands in the U.S. (EPA, 2016). This makes the resource scarce on a national scale. Freshwater riparian wetlands in coastal watersheds are scarce accounting for less than 2% of the total wetlands in the U.S. (Dahl and Stedman, 2013).	An assessment of wetlands in the U.S. conducted by the USGS found that the west has lost anywhere from 50 to 95% of its wetlands (Dahl & Allord, 1997). The national wetland condition assessment survey conducted by EPA found that of the 3 million acres of wetlands remaining in the west only 20% are in good health, the remainder are degraded in some way (EPA, 2016).	In California, 95% of all historic wetlands have been lost (Dahl & Allord, 1997). With climate change, nearly all wetlands could be lost by 2100 (Thorne et. al., 2018). This is particularly problematic as wetlands allow for groundwater recharge (EPA, 2016) and that the value of wetlands statewide in California is between $6.3 and $22.9 billion (CalEPA, 2016).
Grassland	While grasslands were once ubiquitous with large swaths of the counts, studies indicate that millions of acres are lost every year and replaced with row crops at a rate of about 2% per year (World Wildlife Fund, 2021). Grasslands are vital for ground water recharge and flow regulation, carbon storage, erosion control, climate mitigation, pollination (Bengtsson et. al., 2019).	The majority of the grasslands in the U.S. are in the central and midwestern states. In the west, the primary grassland ecosystem is in the Central Valley of California.	Only about 1% of California's native grasslands remain, the others have been heavily invaded by non-native species or converted to other uses (CNGA, 2022). Currently over 73 grassland-associated species are listed by the state & federal Endangered Species Acts in addition to many other native pollinators and other species experiencing sharp declines (Jantz et. al., 2007).

From a planning perspective, the ecological significance of a habitat is useful in defining the goals and objectives of the compensatory mitigation plan. Given the scarcity and value of these habitats, mitigation targets are no net loss of in-kind habitat value or acreage for riparian and wetland habitats. Recognizing that existing grasslands are likely already primarily composed of non-native species, the mitigation goal is no net loss of habitat value, while minimizing loss of in-kind habitat value for grasslands.

6. Mitigation Planning Objectives

The LSJR Project includes mitigation sequencing actions employed during the development and refinement of details for each option. These sequencing actions include steps to avoid, minimize, rectify, and reduce/eliminate habitat impacts for each option. These actions are part of the overall mitigation plan for the LSJR Project. The need for compensatory mitigation is driven by the remaining unavoidable impacts to significant ecological resources.

The goal of this mitigation plan is to fully compensate for the unavoidable impacts to significant ecological resources that would occur with implementation of the LSJR Project. Compensation requirements were defined by the quantified results of the habitat impact assessment model, completed as part of the Feasibility Study, as designs are completed, these values may require revision. The objectives of this mitigation plan are:

- Compensate for the loss of 139 acres of riparian habitat (72.1 AAHUs; up to 417 acres) in the San Joaquin River basin.
- Compensate for the loss of 10.75 acres of wetland habitat (7.68 AAHUs; up to 32.25 acres) in the San Joaquin River basin.
- Fully compensate for the unavoidable loss/damage to up to 19,630 linear feet of shaded riverine aquatic habitat within the San Joaquin River watershed as mitigation for adverse effects to listed fish species, including temporal impacts, in accordance with requirements in the biological opinion.
- Fully compensate for the unavoidable loss/damage of an estimated 0.5 acres of aquatic giant garter snake habitat within the recovery unit as mitigation for adverse effects to giant garter snake, including temporal impacts, in accordance with requirements in the biological opinion.
- Fully compensate for the unavoidable loss/damage of an estimated 12.5 acres of upland giant garter snake habitat within the recovery unit as mitigation for adverse effects to giant garter snake, including temporal impacts, in accordance with requirements in the biological opinion.
- Fully compensate for the unavoidable loss/damage of an estimated 134.5 acres of riparian and non-riparian habitat (as applicable) supporting elderberry shrubs in accordance with the 2017 VELB framework within the recovery unit as mitigation for adverse effects to the valley elderberry longhorn beetle, including temporal impacts, in accordance with requirements in the biological opinion.
- Fully compensate for impacts of complete loss of shallow water habitat that supports Delta Smelt, green sturgeon, spring-run Chinook salmon and steelhead, due to construction of the two closures structures by purchase of credits at a Service-approved conservation bank at a ratio of 3:1 (credits : acres of impact). = The area of the Fourteenmile Slough gate impact is estimated to be 0.7 acre, so the credit purchase will be 2.1 acres.
- Fully compensate for permanent impacts of partial loss of shallow water habitat function within an estimated 170 acres in Fourteenmile Slough, due to operation of the closure structures on tidal action and habitat access with: (b) for Fourteenmile Slough – purchase of 17 credits (acres) at a

Service-approved conservation bank. *Smith Canal compensation is complete.

- Fully compensate for the unavoidable loss/damage of an estimated 1.52 acres of open water habitat within federally designated Delta Smelt critical habitat as mitigation for adverse effects to Delta Smelt, including temporal impacts, in accordance with requirements in the amended biological opinion.

Other factors that may influence planning objectives and the development of strategies, measures, and options include the following: timing, legal and policy requirements, and scientific and technical standards. These factors have been used to develop screening criteria and will be used in plan selection with consideration to circumstances and opportunities. Specifically, the following factors have been included in the screening criteria:

- It is USACE policy to acquire lands or interests in lands for mitigation prior to construction of the project commences and the physical construction of the mitigation work is required to be carried out before or concurrently with project construction (Section 906[a] of WRDA 1986, as amended).

- Larger contiguous land tracts may offer better habitat value for fish and wildlife compared to dispersed smaller areas.

- If private land is to be used, it must be acquired in fee.

- For mitigation parcels to succeed, irrigation is required for the first 3-5 years; therefore, water rights must be included with the property.

- Since the mitigation must remain in perpetuity, a conservation easement is required for public land acquisitions.

- The greater the distance a proposed mitigation site is from a project impact site, the higher the mitigation ratio will be.

- Proposed mitigation sites adjacent to sites with an existing source population of a target species are presumed to have higher value than those more isolated.

- Proposed mitigation sites which offer connectivity for populations of target species or wildlife in general are presumed to have higher value than those more isolated.

- Climate change shall be considered for the future sustainability of the site.

USFWS released a mitigation policy on May 15, 2023 (USFWS, 2023), which contained the following additional compensatory mitigation guidance:

- Regarding compensatory mitigation the overall goal is no net loss.
- A landscape approach should inform mitigation.
- Mitigation measures should be durable and resilient to change.
- Compensatory mitigation measures should be implemented before impacts to prevent temporal loss.
- Compensatory mitigation must be in kind for the listed, proposed, or at-risk species affected by the proposed action (i.e., the offsets from compensatory mitigation must benefit the same species affected by the action).
- Compensatory mitigation measures should provide benefits beyond baseline conditions, generally at the mitigation site, that can offset the adverse effects of the action on listed species or critical habitat.
- Compensatory mitigation projects should achieve conservation objectives within a reasonable timeframe and for at least the duration of the impacts.
- The mitigation provider secures compensatory mitigation through adequate legal, real estate, and financial protections that ensure the success of the mitigation.

7. Land Considerations

The interagency team assessed various lands in the study area for potential use as sites for compensatory mitigation work. Parcels within the watershed and capable of supporting the types of habitat(s) impacted by the LSJR Project were identified. Geographic information system tools were utilized to systematically identify tracts of suitable size with habitat support characteristics. An initial qualitative assessment of mitigation potential was also part of the site analysis. Details of each land type identified and assessed are discussed below.

City land. The city owns several large unused or underutilized parcels of land within the watershed. Of particular interest is the Van Buskirk golf course which is slated for redesign and a pump station which is utilizing approximately 10 acres out of the 114-acre parcel. The city has identified these areas as conservation and/or recreational lands and has no plans for future development of these areas, other than as possible green space. These sites contain degraded habitat and have the potential for use as compensatory mitigation lands. Both parcels are located near existing habitat, which could increase the functionality of the habitat and increase connectivity. Per capita, the city has limited parkland; as a percentage of overall acreage (Trust for Public Land, 2022), therefore, any mitigation proposed should be considerate to not further reduce publicly accessible greenspace.

County land. The county does not own any significant tracts of land within the watershed that would be suitable for mitigation use. However, the county does have greenbelts and agricultural reserves identified in their zoning code. These zoned areas are largely privately held. Compensatory mitigation could be compatible with these zoning types as agricultural reserves specify that natural open space areas, compatible public, quasi-public, and park uses are compatible.

State land. The State of California owns numerous parcels within the watershed. Many of these parcels are already committed to wildlife uses; however, some are still undergoing the rehabilitation process. Accordingly, there may be partnership opportunities to meet the compensatory mitigation needs for the LSJR Project. One such parcel is the Franks Tract Recreation Area. This sunken island is currently used for boat-in wildlife watching; however, the California Department of Fish and Wildlife is in the planning process to restore the area to improve habitat.

Federal land. USACE owns several dredged material placement sites that could be used as compensatory mitigation sites. However, all dredged material placement sites are currently used for dredging activities on the Sacramento and Stockton Deep Water Ship Channels. However, if any sites are not regularly used, and it could be financially advantageous to the government to redesignate the use of these parcels to support compensatory mitigation needs for this project and other projects in the USACE Sacramento District portfolio.

Other trust land. There are several tracts of trust lands located in the watershed. The Nature Conservancy owns and manages Staten Island in the watershed; however, it is currently unclear what the future use of the property is. Other Delta islands are owned by DWR, however, these also may no longer be available for use as mitigation, as many have already been used for these purposes.

Private land. Within the watershed there are dozens of sites held in private ownership that are potentially suitable in size and site conditions for mitigation work. These areas vary greatly in conditions and current uses. Some are actively used in agriculture and others are converting to more suburban uses while others are undeveloped. The undeveloped sites further vary in uses with some serving as recreational lands, hunting lands or forestry investments. These lands are considered potential mitigation areas and can be further evaluated for use in mitigation work in collaboration with the resource agencies and the individual landowners.

Onsite option. Onsite mitigation is considered rectification of habitat loss and is not described in this compensatory mitigation plan. Where feasible, on-site options will be pursued as these are the most cost-effective strategies. Use of on-site rectification of habitat will be described in the design documents and associated NEPA/CEQA documents for individual improvement sites.

8. Mitigation Strategies

Planning strategies are different means employed to develop an options plan or plans to achieve a project goal. The use of one or more strategies helps teams focus on an approach to developing a plan. For mitigation planning work, strategies may range from the purchase of mitigation bank credits to the construction of a project or projects to achieve the objectives and compensate for unavoidable habitat impacts. Strategies may also involve different approaches to site selection such as the use of public lands or identifying contiguous sites to enhance wildlife corridors or expand wildlife populations. In addition, Section 2036(c) of WRDA 2007, as amended, (PL 110-114) requires USACE to consider mitigation banks and in-lieu fee programs where appropriate. Consideration of these options as mitigation strategies may be helpful when available. The strategies considered for planning this mitigation plan are described below.

- **Purchase of mitigation bank credits**. Mitigation banks sell credits for mitigation work performed at an approved site. The banks are approved and legally bound through banking instruments that hold the operators to certain standards of performance and reporting. The use of mitigation banks for a project may offer advantages to the government and non-federal sponsor by reducing performance risk and eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans.

- **Purchase of in-lieu fee program credits**. In-lieu fee programs are established by state or local natural resource management agencies and approved by USACE and U.S. Environmental Protection Agency (EPA) to accept funds for future mitigation work. The programs are approved to implement either specific or general wetland or other aquatic resource development projects. Programs must meet the requirements that apply to an offsite mitigation effort and provide adequate assurances of success and timely implementation. A formal agreement between the program sponsor and the agencies, like a banking instrument, defines the conditions under which the use of the program is considered appropriate. Using an in-lieu fee program for a project's mitigation needs may offer advantages to the government and non-federal sponsor by reducing performance risk and eliminating project specific requirements for operations and maintenance work and the development of monitoring and adaptive management plans. In-lieu fee programs may not be acceptable for impact to ESA listed species since it is disadvantageous to the species to wait for future mitigation efforts. This would likely result in higher mitigation ratios to ameliorate excess temporal effects.

- **Construction of a mitigation project**. The government and non-federal sponsor may choose to construct a mitigation project. This construction strategy offers some potential advantages in tailoring a project to specific needs or locations. In addition, the partners may bring special expertise to the project gained from previous work on similar projects in the area.

- **Combination of mitigation bank and/or in-lieu fee program credit purchases and construction of a project**. One potential strategy is to combine both approaches – a bank credit purchase and project construction – together to achieve the mitigation objectives. This strategy could allow the partners to tailor a plan to the needs of some small impacts in one habitat and larger impacts to another habitat type.

- **Non-structural mitigation methods**. Various non-structural approaches may be available for accomplishing mitigation objectives. These approaches generally do not involve major construction work and, therefore, could potentially reduce some associated environmental impacts. These actions may include land preservation, invasive species control, environmental flows, or other management actions that produce ecosystem benefits. As a strategy, reducing environmental impacts may be more appropriate and complimentary in sensitive or protected areas. Non-structural mitigation may be combined with all other mitigation strategies to guide formulation of option plans.

- **Partnership opportunities**. Many organizations have goals that align with Corps of Engineers mitigation planning needs, the Environmental Operating Principles, or other missions. Opportunities may exist to collaborate to plan a project that meets the goals of the mitigation plan and the watershed goals of one or more partners. For instance, one organization such as California State Parks may have a recreation focus on their projects, whereas USACE might be focused on creation of habitat for the purposes of mitigation. By combining funds, or sharing a parcel of property, and working together to ensure compatibility the agencies can build a better project together to meet multiple objectives. This strategy offers an opportunity to benefit from the strengths of organizations outside of government and may leverage existing information or offer unique local insight. There may be opportunities to perform habitat mitigation work on lands managed by partners.

9. Mitigation Measures and Options

Management measures are actions or activities that work towards accomplishing planning objectives. A measure may stand alone as a single activity that serves as an option plan, or two or more individual measures may be combined to form an option plan.

- **Measure 1** – Purchase mitigation bank credits. For ESA credits, USACE would purchase appropriate habitat credits from a USFWS or NMFS-approved bank, as appropriate, in the service area. This measure addresses the mitigation objectives through the purchase of in-kind credits from an approved mitigation bank located in the basin.
- **Measure 2** – Purchase in-lieu fee program credits. This measure addresses the mitigation objectives through the purchase of in-kind credits from an approved in-lieu fee program with credits available in the basin. An in-lieu fee program could also include funding needed studies for the benefit of ESA listed species, in coordination with USFWS and NMFS.
- **Measure 3** – Use dredged material to create shallow water Delta Smelt habitat. This measure addresses the mitigation objectives through the physical construction of shallow water habitat in an area that is currently open water.
- **Measure 4** – Restore hydrology to create wetland and riparian habitat. This measure addresses the mitigation objectives by reintroducing appropriate water levels to restore wetland and riparian areas in modified and/or degraded sites.
- **Measure 5** – Change topography to create wetland and riparian habitat. This measure addresses the mitigation objectives by lowering or raising surface elevations to heights conducive to the growth of wetland or riparian vegetation. Similar to Measure 3, where outside fill is needed, USACE would give consideration to beneficially reusing dredged material.
- **Measure 6** – Plant suitable wetland and riparian vegetation. This measure addresses the mitigation objectives by transplanting vegetation suitable for growth in wetlands or riparian habitats.
- **Measure 7** – Remove rock to restore shaded riverine aquatic habitat. This measure addresses the mitigation objectives by removing bank hardening where it is no longer needed for the benefit of listed fish species.
- **Measure 8** - Transplant elderberry shrubs into an area to be preserved in perpetuity, plant additional seedlings, as required, to ensure no loss of habitat value. This measure addresses the mitigation objectives by reducing the loss of valley elderberry longhorn beetle and compensating for any transplant losses.
- **Measure 9** - Eradicate non-native and invasive water weeds to improve habitat for listed fish species. This measure addresses the mitigation objectives by restoring open water habitat for the benefit of Delta Smelt.

A qualitative analysis of the potential effectiveness of each measure towards achieving the mitigation planning objectives was performed and is summarized in Table 9. After the effectiveness screening, the team retained eight measures for further consideration and potential combinability into option plans. Each measure was further assessed to determine the potential to combine it with other measures to form option plans. This assessment determined if a measure could stand alone as a plan and whether the measure had any restrictions that would prevent its combination with other measures.

Table 9- Initial Screening of Mitigation Measures

Measure		Likely to meet mitigation objective?	Carried forward for further analysis?	Ability to combine with other measures?	Rationale
1	Bank Credits	Yes. Partially.	Yes	Yes	Bank credits provide an immediate habitat offset for LSJR Project impacts without a temporal lag and alleviate the USACE and its non-federal partner from the long-term monitoring and maintenance of the site. However, bank credits are not available for all species or habitat types and cannot fully meet the needs of the LSJR Project.
2	In-lieu fee	Yes. Partially.	Yes	Yes	In-lieu fee programs alleviate the Corps and its non-federal partner from the long-term monitoring and maintenance; however, there could be a significant time lag between when the fee is paid and when habitat benefits accrue. In addition, in-lieu fee would not be acceptable for habitat losses for ESA listed species.
3	Beneficial reuse of dredged material	Yes. Partially.	Yes	Yes	Beneficial reuse sites would likely only benefit a few species and habitat types; therefore, this measure cannot stand alone.
4	Restore hydrology	Yes. Partially.	Yes	Yes	Restoration of hydrology would likely be a component of construction of a mitigation project; however, restoration of hydrology alone is not sufficient to restore the numerous habitat types and species impacted.
5	Change topography	Yes. Partially.	Yes	Yes	Changing topography would likely be a component of construction of a mitigation project; however, changing topography alone is not sufficient to restore the numerous habitat types and species impacted.
6	Plant vegetation	Yes. Partially.	Yes	Yes	Planting vegetation would likely be a component of construction of a mitigation project; however, planting vegetation without also changing topography or restoring hydrology would not likely create a self-sustaining site.
7	Remove rock	Yes.	Yes	Yes	Removing rock could potentially benefit all listed species and habitats; however, finding sites of sufficient size is likely to be challenging.
8	Transplant elderberry	Yes. Partially.	Yes	Yes	Transplanting elderberry would only benefit valley elderberry longhorn beetle and riparian habitats but would not meet the objectives for other species.
9	Eradicate non-native vegetation	Yes.	No	Yes	Removing non-native vegetation could benefit all species and habitat types; however, it represents an on-going cost commitment which would exceed the authority of the LSJR Project.

The measures were then combined into an array of option plans aligned with the mitigation planning strategies. A no action option is included as a basis for comparison as well as meeting the requirements of the National Environmental Policy Act.

- Option 1 – purchase mitigation bank credits. To be considered as an option, a mitigation bank: must be approved through the USACE Regulatory Program, as demonstrated by a banking instrument; has to provide available or potential in-kind credits; has to have a service area that includes the location where LSJR Project impacts occur; and has to have completed a functional analysis of credits using a USACE certified habitat assessment model (Implementation Guidance for Section 1163 of WRDA 2016). For ESA listed species, the mitigation bank must also be USFWS/NMFS approved and in the appropriate service area where the impact occurred. Given those requirements, the following mitigation banks have credits that could be used as compensatory mitigation for this project are summarized in Table 10, service areas are shown in Appendix D. This option only incorporates Measure 1.

Table 10- Summary of Mitigation Banks in the LSJR Project Service Area

Bank Name	Operator	Species/ Habitat Type	USFWS/ NMFS Approved?	Acres/credits available
Grasslands Mitigation Bank	Westervelt Ecological Services	Giant Garter Snake	USFWS Approved	Yes
		Wetlands	USFWS Approved	Yes
French Camp Mitigation Bank	Delta Habitat LLC	Valley Elderberry Longhorn Beetle	USFWS Approved	New credits soon available
River Ranch Conservation Bank	Wildlands Inc.	Valley Elderberry Longhorn Beetle	USFWS Approved	Yes
Fremont Landing Conservation Bank	Wildlands Inc.	Riparian / Salmonids (SRA)	USFWS/ NMFS Approved	Yes
Johnson Cosumnes	Westervelt Ecological Services	Riparian / Salmonids (SRA)	No	Anticipated Approval 2024-2025
Zacharias Ranch	Westervelt Ecological Services	Riparian / Wetland / Salmonid (SRA)	No	Anticipated Approval 2025-2026
Cache Slough Mitigation Bank	Westervelt Ecological Services	Riparian / Wetland / Salmonid (SRA)/ Sturgeon	No	Anticipated Approval 2026-2027

- Option 2 – purchase credits from an approved in-lieu fee program. To be considered as an option, an in-lieu fee program: must be approved through the Regulatory Program, as demonstrated by an in- lieu-fee program instrument; has to provide available or potential in-kind credits; has to have a service area that includes the location where LSJR Project impacts occur; and has to have completed a functional analysis of credits using a Corps of Engineers certified habitat assessment model, consistent with the model used to determine LSJR Project impacts (Implementation Guidance for Section 1163 of WRDA 2016). There is only one in-lieu fee program that is currently approved for the Sacramento region that covers the Stockton area; however, the services may also approve research funding for ESA listed species which functions similarly to in-lieu fee programs. Grant research would be conducted similarly to an in-lieu fee set up wherein set research objectives and a set grant dollar amount would be established in writing to meet a specific mitigation objective for a species. Providing funding for the research endeavor would satisfy a portion of the mitigation requirements for species of concern, regardless of the outcome of the research. Options for in-lieu fee programs are summarized in Table 11. This option only incorporates Measure 2.

Table 11- Summary of In-Lieu Fee Programs in the LSJR Project Service Area

In-lieu fee instrument	Species/habitat	Program Sponsor
National Fish and Wildlife Fund (NFWF)	Wetlands	USACE
Grant research funding	Any ESA listed species	USFWS/NMFS

- Option 3 – construct a mitigation project. There are several parcels which have been identified as potential candidates for construction of mitigation projects. These will be described below as 3A, 3B, 3C, etc. The specifics on the quantity of each type of habitat that could be established on each parcel varies. Since the construction of a mitigation project is complex, each construction could include any combination of Measures 3, 4, 5, 6, 7, and 8.

Where additional fill is required, USACE would consider beneficially re-using dredged material. Use of dredged sediments improves sustainability by reducing wastes, reducing the need to acquire fill from borrow sites, and may reduce transport distances due to proximity to the Stockton Deep Water Ship Canal. Prior to use, sediments would be tested to determine suitability for ecological use and in zones establishing hydric soils in wetland and riparian areas. Testing would include physical evaluations (e.g., grain size), chemical evaluations, and toxicity (including, but not limited to mercury, PCBs, DDT).

While the exact planting palette for a proposed mitigation site would depend on site specifics, a description of the types of vegetation that could be planted for each habitat type is included in Table 12. Table 13 summarizes the total cost of construction per parcel, while Table 14 summarizes the habitat potential of each parcel. Detailed descriptions of each proposed parcel follows:

Table 12- Representative Vegetation for Each Habitat Type

Habitat Type	Potential Species (including but not limited to):
Riparian	*Acer negundo* (box elder), *Cercis occidentalis* (western redbud), *Fraxinus latifolia* (Oregon ash), *Juglans californica* (California black walnut), *Platanus racemosa* (Western sycamore), *Populus fremontii* (Fremont's cottonwood), *Quercus lobata* (valley oak), *Salix* sp. (willow), *Rubus ursinus* (California blackberry), *Frangula californica* (coffeeberry), *Cephalanthus occidentalis* (buttonbush), *Helinium puberlum* (sneezeweed), *Oenothera hookerii* (evening primrose)
Wetland	*Carex aquatilis* (water sedge), *Baccharis salicifolia* (mulefat), *Bolboschoenus robustus* (sturdy bullrush), *Cyperus eragrostis* (umbrella sedge), *Juncus effusus* (soft rush), *Sagittaria latifola* (Wappato), *Schoenoplectus acutus* (Hardstem bulrush)
Grassland	*Achillea millefolium* (yarrow), *Asclepias fascicularis* (narrow leaved milkweed), *Clarkia purpurea* (purple clarkia), *Elymus glaucus* (Blue wildrye), *Festuca microstachys* (small fescue), *Lupinus bicolor* (miniature lupine), *Trifolium wormskioldii* (cows clover)

Table 13- Summary of Potential Mitigation Projects for Construction

Parcel Name	Ownership Type	Approximate Parcel Size	Estimated Cost*
3A. 14-mile pumpstation	Public	104 acres	$19,262,984.42
3B. In River Parcel	Private	20 acres	$9,865,780.56
3C. San Joaquin River West	Private	59 acres	$12,650,959.72
3D. Van Buskirk**	Public	50 acres	$29,386,762.53
3E. Manteca	Private	170 acres	$29,463,906.81
3F. Calaveras	Private	40 acres	$11,977,150.90
3G. On River Parcel	Public	100 acres	$28,072,612.45
3H. "Unidentified Parcel"	Varies	Varies	Varies
3I. On-site Mitigation	Varies	Varies	Varies

Notes:
**Estimated costs include acquisition, planning and design, construction, and the first 5 years of monitoring, maintenance, and adaptive management.*
***Costs for Van Buskirk include a setback levee therefore the costs of the mitigation only are lower.*

Table 14- Summary of Habitat Potential at Each Site

Name	Wetland (acres)	Riparian (acres)	GGS	VELB	Delta Smelt	NMFS Fish (SRA)
14 Mi. Pumpstation	41.65-acre mosaic habitat site				-	-
In River	0	20.0	-	X	X	15,000 LF
SJRW	2	41	X	X	-	-
Van Buskirk	10	27	X	X	X	9600 LF
Manteca	5	145	X	X	-	-
Calaveras	0	40	X	-	-	11,000 LF
On River	25	75	-	X	X	15,000 LF
Estimated Total	49	413				50,600 LF

Note: The amounts of habitat that could be created for ESA listed species is variable dependent on design. An X denotes that suitable habitat for a listed species could be created. A dash (-) indicates that suitable habitat could not be created on the subject parcel due to distance from known populations, hydrology, or other factors. Exact values are subject to change based on lost acres due to existing easements, access roads, and other unusable acres.

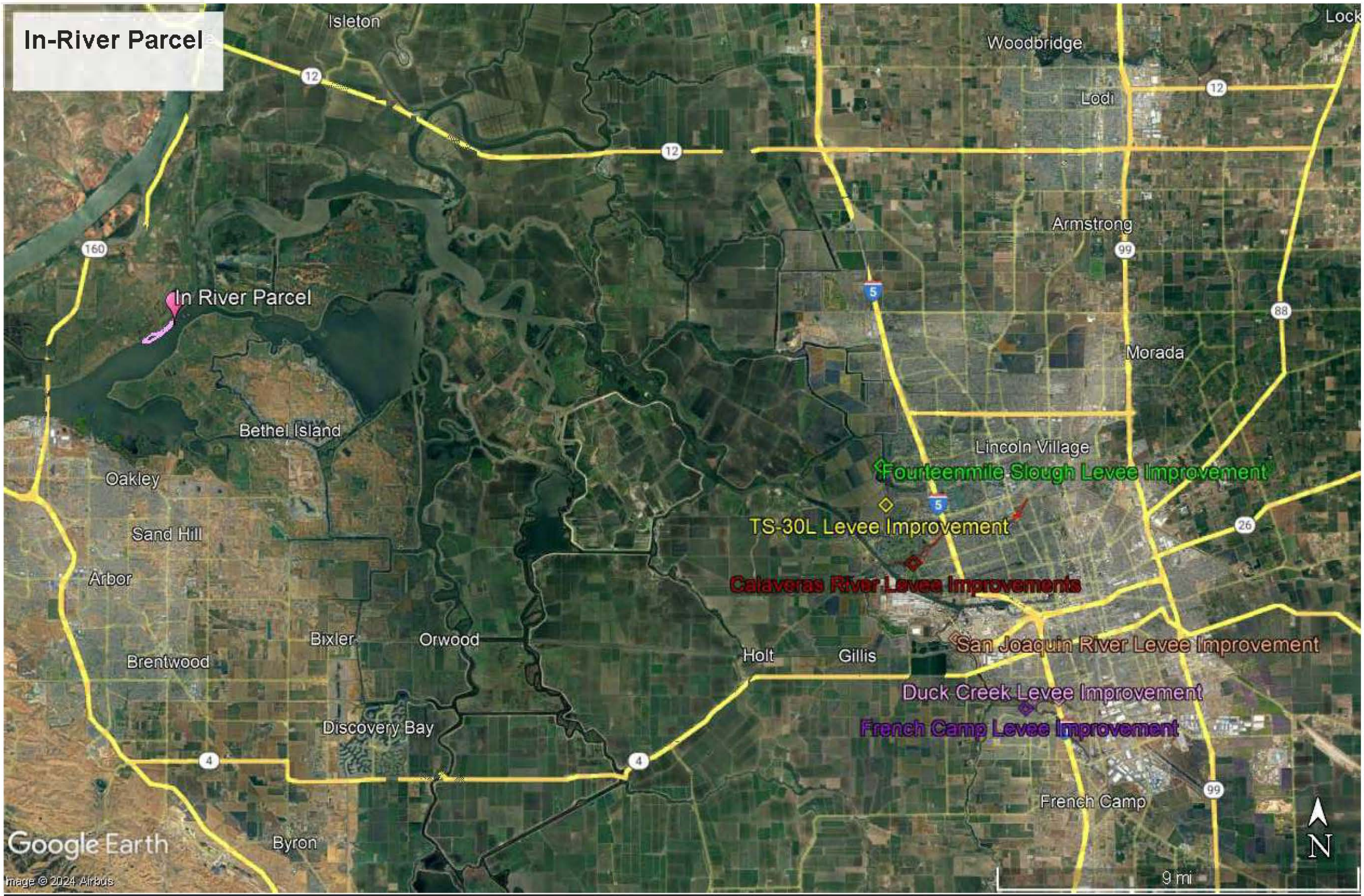
3A- 14 Mile Pumpstation

Project Description: This parcel is publicly owned. It is adjacent to both the Fourteenmile Slough proposed levee improvement and the proposed closure structure for the LSJR Project. The property is generally subsided and sits an average of 2 feet below sea level. It is surrounded by levees with access roads on the channel facing side. Historically, the parcel was used as a wastewater treatment area which featured a pumpstation, oxidation, and sludge ponds. Operations at the property ended in 1979, and the original pumping plant was demolished in 2008. There is uneven grading on the site due to the presence of the ponds, and there is the potential for residual contamination of some regulated substances. The USACE and its non-federal sponsors completed a phase one environmental site assessment, which recommended further soil testing. During a site visit, it was observed that volunteer vegetation has established in several locations. Some species appeared to be native. Songbirds and raptors were present on the day of the site visit.

LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Public- City of Stockton	104.39 acres	Riparian, potentially elderberry

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	7 acres	giant garter snake	Yes	5- change topography to support wetland and riparian habitats; 6- plant appropriate vegetation; 8- transplant elderberry to the site; Compensatory habitat could be built for GGS and VELB, in addition to wetland and riparian habitats. However, because there are properties that still require protection from flooding adjacent to this site, notching the levee to allow hydraulic connection would not be feasible, which precludes habitat creation for Delta Smelt and NMFS listed fish species.
Riparian	65 acres	VELB	Yes	
		Delta Smelt	No	
		NMFS Listed Fish	No	

3B- In River Parcel

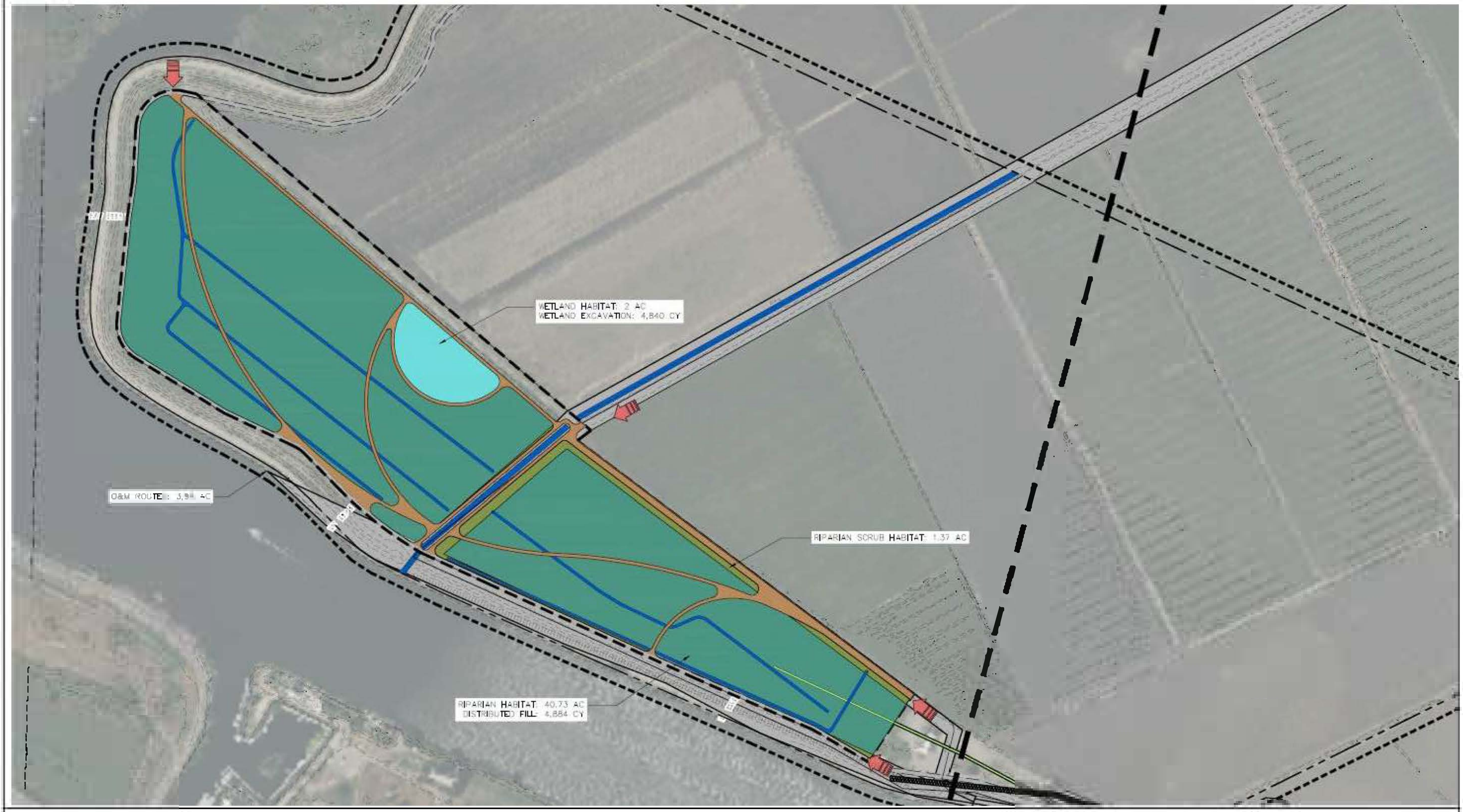


Project Description: This privately owned parcel is located in the legal Delta near the LSJR Project area and is listed for sale at the time of this draft plan. The parcel is an island with no access by land. Native vegetation surrounds the shoreline, with some native shrub vegetation near the islands center. The island is low lying and vulnerable to rising sea levels.

LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Private	20 acres	Riparian, SRA, Shallow Water

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	0 acres	giant garter snake	No	5- change topography to support riparian habitats, cut new channels for SRA6- plant appropriate vegetation. Parcel is low lying, in the channel, and therefore could provide SRA habitat and would be suitable for riparian habitat in the center, this habitat is expected to evolve with climate change.
		VELB	No	
Riparian	20 acres	Delta Smelt	Yes	
Shallow Water	0 acres	NMFS Listed Fish	Yes	
SRA	15, 000 LF			

3C- San Joaquin River West Parcel

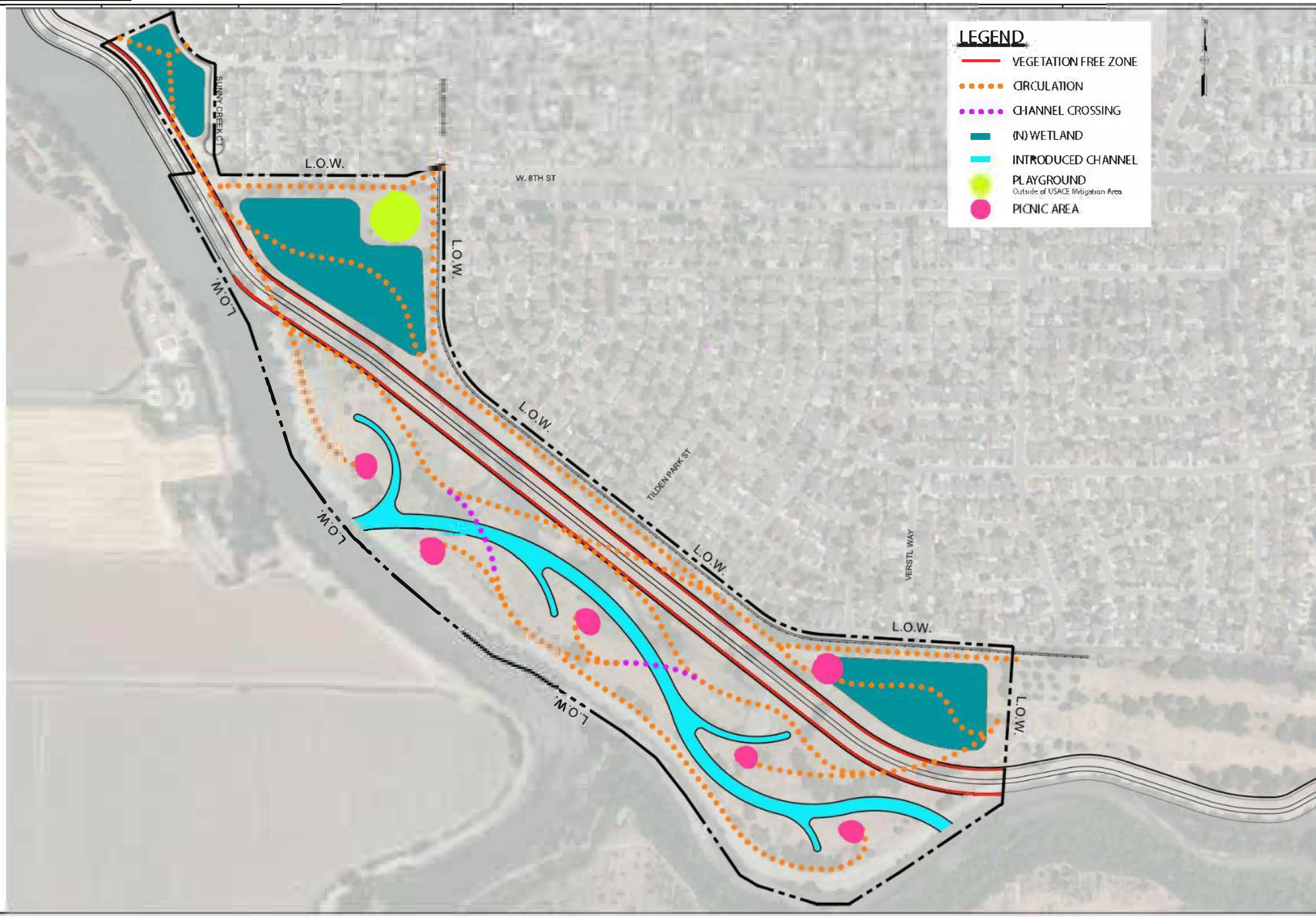


Project Description: The parcel was purchased by the San Joaquin Area Flood Control Agency in December 2023 to meet the mitigation needs for TS30L. The parcel includes several agricultural ditches which could be restored to wetlands. There are no easements on this property aside from right of way access for the roads and levees. The property has been used for growing rice and row crops in the past.

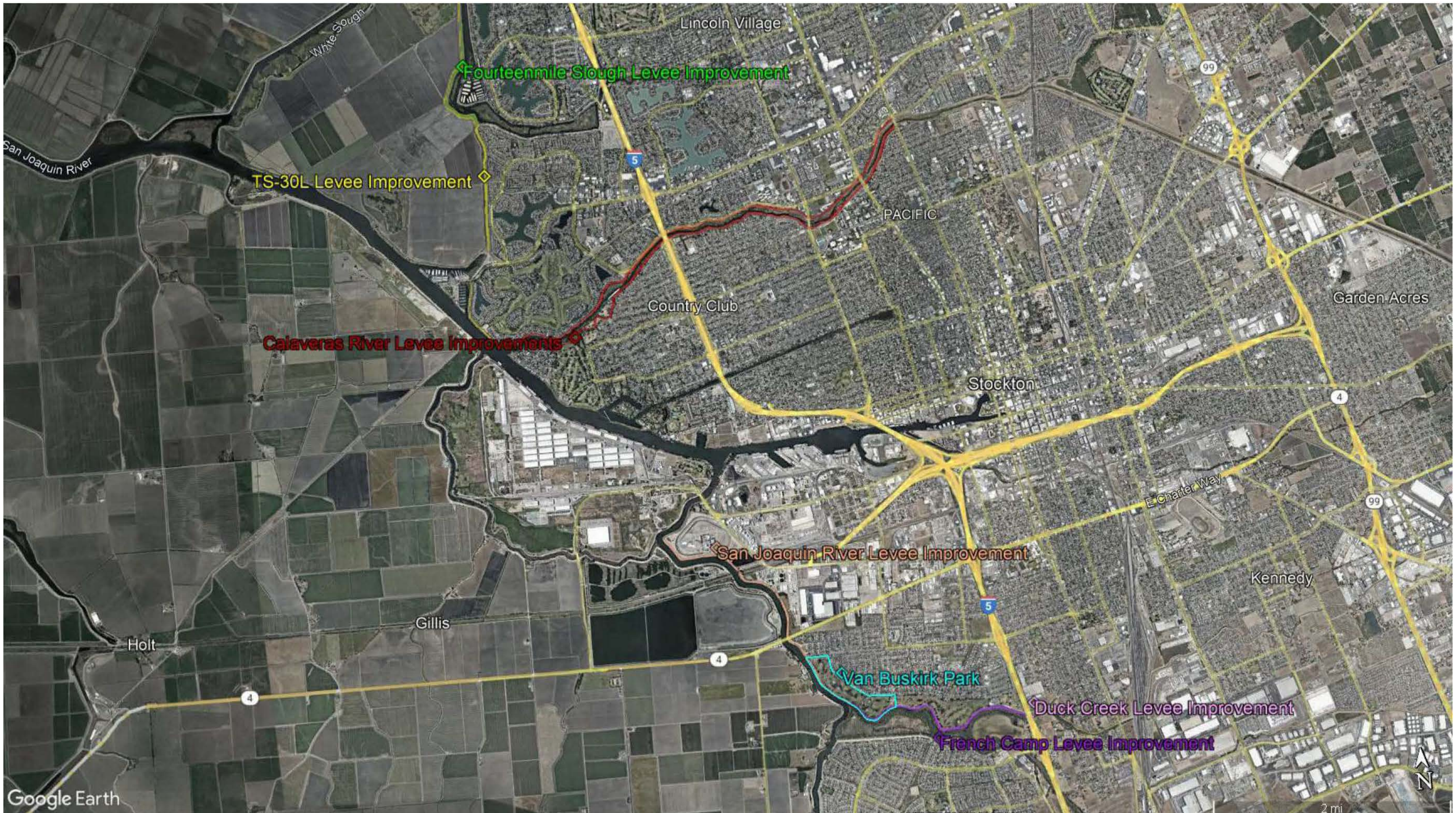
LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Private	50.0 acres	Agricultural ditches

Potential Habitat	Acres	ESA Species	Suitability	Measures Employed
Wetland	2 acres	giant garter snake	Yes	5- change topography to support wetland and riparian habitats;
		VELB	Yes	6- plant appropriate vegetation;
Riparian	41 acres	Delta Smelt	No	Compensatory habitat will be built for GGS in addition to wetland and riparian habitats. Elderberry have been transplanted and several are present on site. However, because there are properties that still require protection from flooding adjacent to this site, notching the levee to allow hydraulic connection would not be feasible, which precludes habitat creation for Delta Smelt and NMFS listed fish species.
		NMFS Listed Fish	No	

3D- Van Buskirk Park



Project Description: The Van Buskirk Park was a public golf course; however, due to insufficient funding, the golf course was shuttered. The City of Stockton has recently been working on redesign plans for the entire park. Discussions with City staff have indicated the desire to convert half the park to habitat for low impact recreational activities such as walking, running, and nature appreciation, while reserving the other half of the park for developed recreation uses. The draft concept shown only includes the half of the park designated for low impact recreation. The public has generally been supportive of the split park idea. Currently, the park has an estimated 350 ornamental trees planted with some wildlife value and some of the old golf course features that have become degraded wetlands.

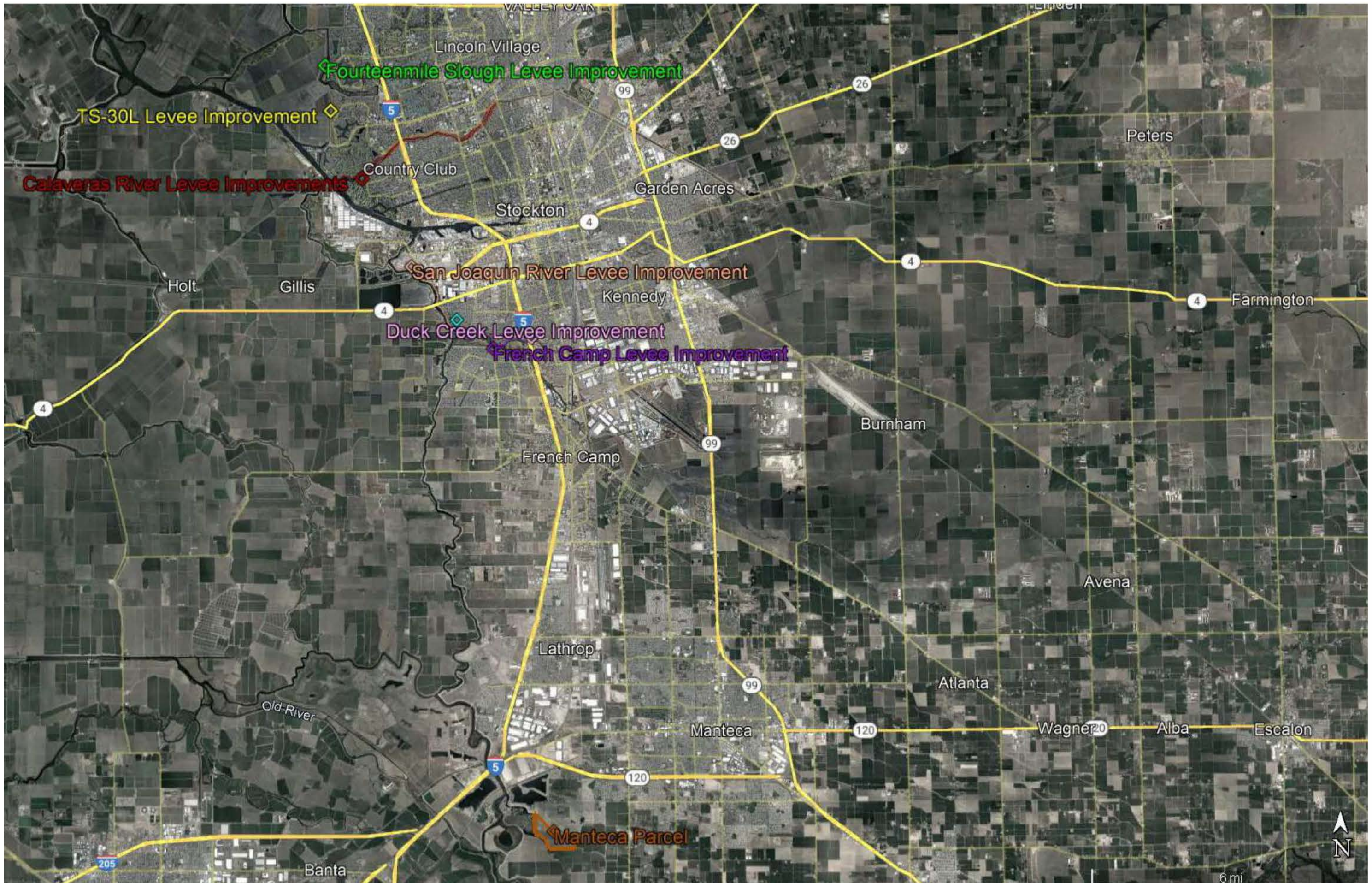


LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Public- City of Stockton	50 acres	Wetland, riparian, SRA

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	10 acres	giant garter snake	Yes	4—Restore hydrology; 5—Change topography; 6—Plant vegetation; 7—Remove rock; 8—Transplant elderberry Construction of this site would entail setting back the levee from its current configuration to restore hydrology, grading and planting to establish appropriate elevations for wetlands and riparian habitat and removing rock from the remnant levee. There is also a possibility to transplant elderberry to this site as the French Camp mitigation bank is just on the opposite side of French Camp Slough.
		VELB	Yes	
Riparian	27 acres	Delta Smelt	Yes	
SRA	9600 LF	NMFS Listed Fish	Yes	

3E- Manteca Parcel

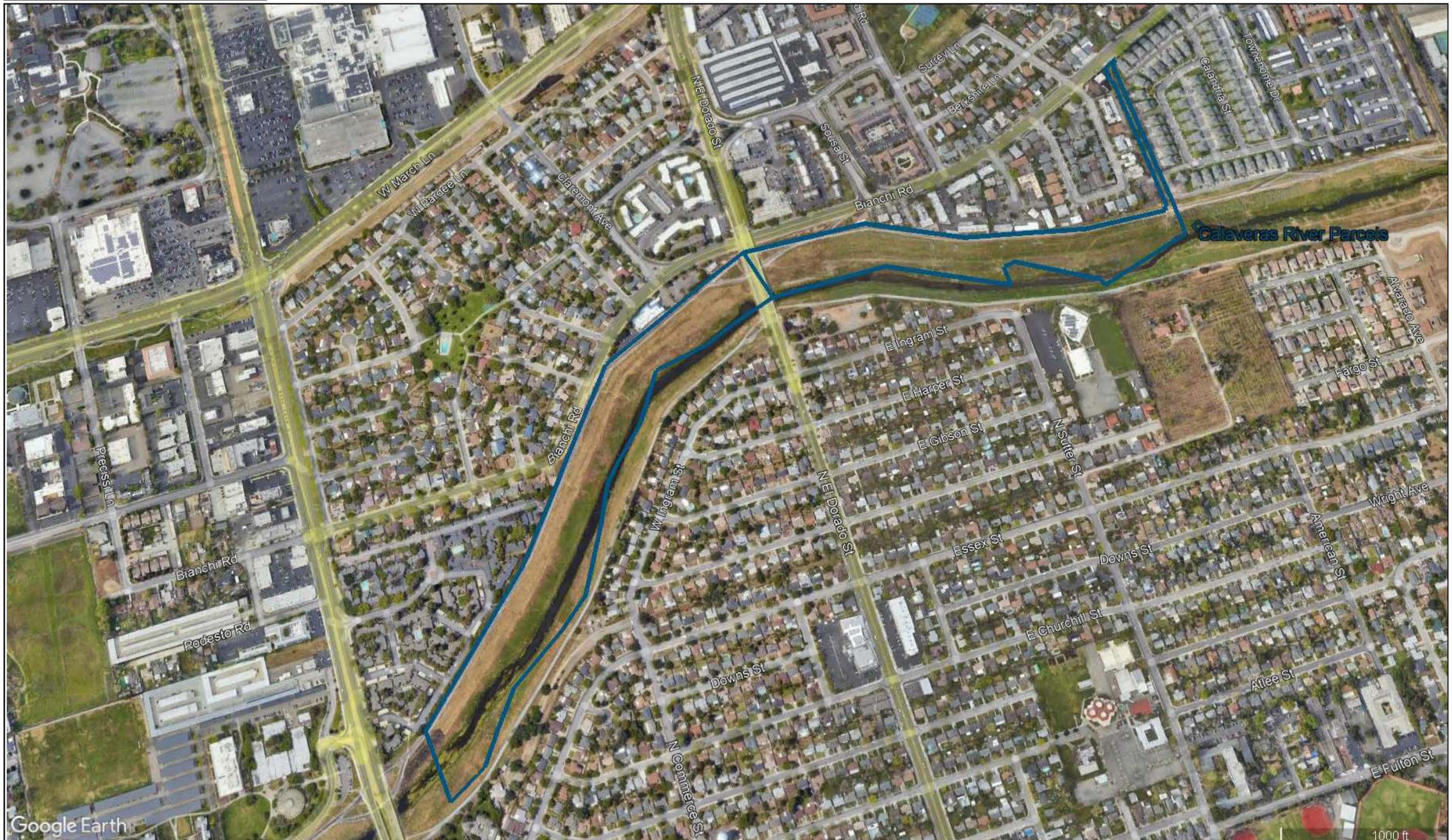
Project Description: This privately owned parcel has been used for row crop agriculture in the past. The property owner is a willing seller. It is currently on the waterside of a newly improved levee and is outside the planned development area for the City of Manteca. Manteca is rapidly developing, and if the site is used, accommodations for pedestrian access may be needed to control and funnel foot traffic. There is quality habitat adjacent to the parcel, numerous songbirds and raptors were observed on the day of the site visit in addition to several large, mature elderberry shrubs.



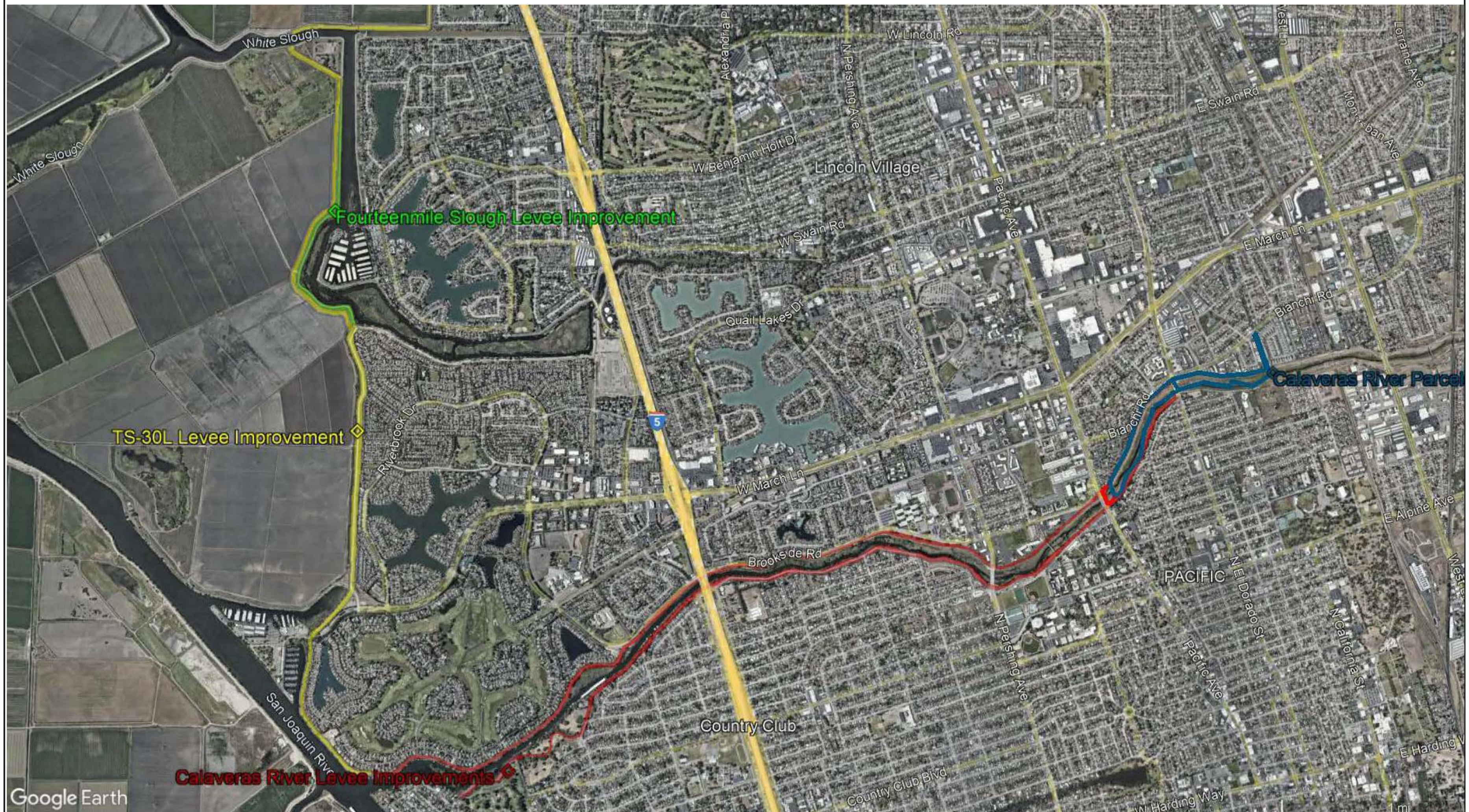
LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Private	170 acres	Riparian,

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	5 acres	giant garter snake	Yes	5—Change topography; 6—Plant vegetation; 8—Transplant elderberry Parcels adjacent to this site have their own berms. In addition, an improved levee has been constructed along the Dredger Cut, which will serve the newly constructed urban areas. Quality riparian habitat exists in the slough adjacent to the parcel; however, the waterway is cut off from the San Joaquin River and therefore not able to serve as SRA habitat. Finally, since large mature elderberry are present in and around the site, the site could also be used for elderberry transplants. The site additionally lies between two disjunct populations of VELB, according to CNDDB.
		VELB	Yes	
Riparian	145 acres	Delta Smelt	No	
SRA	0 LF	NMFS Listed Fish	No	
Shallow Water	0 acres			

3F- Calaveras River Parcels



Project Description: While many of the parcels on the waterside of the levees along the Calaveras River are in public ownership, there are a few remaining private parcels. This parcel is privately owned and the owner is willing to sell the parcel. The parcel partially overlays some of the area where levee improvements are planned. Large woody vegetation is completely absent from this site, but the river is still hydraulically connected and fish are believed to travel up the Calaveras River to the Stockton Diverting Canal, making restoration in this area a key priority for habitat connectivity.



LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Private	40 acres	Riparian, SRA- degraded

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	0 acres	giant garter snake	No	5—Change topography; 6—Plant vegetation Work in this area would be directly along the Calaveras River. The existing habitat is severely degraded. The topography of the site would need to be regraded to ensure sufficient hydraulic capacity in the channel after vegetation is planted. There are no elderberry near the site, and the waterbody is too large to serve as giant garter snake habitat. Likewise, as the channel is not tidally influenced, the site would not be suitable for Delta Smelt.
		VELB	No	
Riparian	40 acres	Delta Smelt	No	
SRA	11,000 LF	NMFS Listed Fish	Yes	

3G- On-River Parcels

Project Description: These two privately owned parcels are listed for sale at the time of this draft plan. The larger parcel has been used as a private hunting club in the past and has an existing boat dock. The habitat condition of the two parcels is currently unknown, but likely possesses some mature vegetation. There are no levees around the sites.

LAND OWNERSHIP TYPE	TOTAL PROJECT ACREAGE	EXISTING HABITAT
Private	95 acres	Riparian, SRA, Elderberry, Wetland

Potential Habitat Acres		ESA Species Suitability		Measures Employed
Wetland	25 acres	giant garter snake	No	4—Restore hydrology; 5—Change topography; 6—Plant vegetation; 8—Transplant elderberry
		VELB	Yes	
Riparian	75 acres	Delta Smelt	Yes	
SRA	15,000 LF	NMFS Listed Fish	Yes	Habitat improvement at the on-river parcels could consist of cutting additional channels for juvenile rearing habitat. Topography could be modified to support desired habitat and vegetation could be planted. It is unknown if elderberry exist at these sites, although elevations appear to be appropriate near the middle of the parcels.
Shallow water	0 acres			

- 3H – Unidentified Parcel(s). Throughout the course of the LSJR Project, the LSJR Project team, in coordination with the resource agencies, may identify additional public or private parcels that are suitable for the construction of mitigation. Any subsequently identified parcels would undergo the same screening with the same criteria as Options 3A-3G.
- 3I – On-site Mitigation. There are a number of on-site mitigation opportunities that could provide cost effective mitigation without compromising flood risk reduction measures. In particular, the following reaches could be suitable for implementation of on-site mitigation:

  - Seismic Remediation Levee Setback at 14-mile slough- The feasibility report included a potential levee setback along 14-mile slough with mitigation as follows:

Potential Habitat Acres		**ESA Species Suitability**		**Measures Employed**
Wetland	0	giant garter snake	Yes	4—Restore hydrology; 5—Change topography; 6—Plant vegetation; 8—Transplant elderberry Construction of the seismic fix would necessitate setting the levee back away from the current location. The remaining area adjacent to 14-mile slough would be planted with an elderberry/riparian mix. Elderberry transplants could also be accepted at this site.
Riparian	14	VELB	Yes	
SRA	0	Delta Smelt	No	
Shallow water	0	NMFS Listed Fish	No	

  - Calaveras River Levee Improvements- Numerous locations along the Calaveras River would be improved. Some segments of the levee have bank area waterward of the levee that could be planted, provided there is sufficient hydraulic capacity in the channel.

  - Shima Tract- Agricultural land is adjacent to the proposed levee improvements at Shima Tract. An adjacent "on-site" mitigation area could be established to create oak riparian forest mitigation.

- Option 4 – combination of mitigation bank credit purchase and constructed mitigation. Purchase mitigation bank credits for available species and habitat types including giant garter snake, valley elderberry longhorn beetle, Delta Smelt, NMFS listed fish, and wetlands. Also, construct one or more of the proposed mitigation sites described in Option 3 to meet remaining mitigation needs. This allows an immediate habitat benefit for species where credits are available and allows construction of mitigation sites for effects to species and habitats for which credits are not available.

- Option 5 – combination of in-lieu fee program and constructed mitigation. Contribute to an in-lieu fee program or a research grant for available species and habitat types and construct one or more of the proposed mitigation sites described in Option 3 for remaining species and habitat types. Currently, there are in-lieu fee programs for wetlands, and research grants could be funded for Green Sturgeon, a NMFS listed fish. Construction of mitigation habitat would be required for Delta Smelt, valley elderberry longhorn beetle, giant garter snake, NMFS listed Salmonids and riparian habitats. This allows an immediate habitat benefit for species where a program or research grant is available and allows construction of mitigation sites for effects to species and habitats for which a program or grant is not available.

- Option 6 – Remove rock along reaches of river where it is no longer required for flood protection purposes. Removal of rock along defunct levees could provide significant habitat benefits to all listed species and habitat types. However, after a review of leveed areas in the LSJR Project area, no significant reaches of defunct levee could be found that were suitable for rock removal. Since the San Joaquin/Stockton area is growing, land is rapidly being developed and many levees are being improved rather than abandoned.

- Option 7 – Form a partnership with another agency who is working on a project which could serve as mitigation for this project and purchase bank credits. The California Department of Fish and Wildlife has completed a feasibility study for restoration of the Franks Tract State Recreation area. With a great deal of the planning work completed, the Franks Tract State Futures project is seeking funding which presents a partnership opportunity. The Franks Tract State Futures project is described fully in the Franks Tract Futures 2020 Reimagined (CDFW, 2021; CDFW, 2021; Appendix A), however, a brief summary is as follows:

> The preferred concept for Franks Tract would redesign the landscape, adding new land masses, tidal marshes, navigation channels, beaches, and other amenities. The design addresses deteriorating environmental, safety, and water quality conditions in the area. Among diverse benefits, it would: improve recreational boating and navigation (through dredging and reduction in aquatic weeds); create beaches, mooring sites, sheltered coves, day-use areas, and other amenities within the state recreation area; improve remnant levees that provide wave sheltering adjacent to Bethel Island and Little Franks Tract while maintaining open water views and marina access; create large areas of tidal marsh, riparian channel edge, and ecologically valuable features that provide habitat for a variety of species, including species of concern, sport fish and waterfowl; improve water quality for human use by reducing salinity in the central and south Delta; and help Franks Tract and local communities adapt to sea level rise.

Many of these goals align with the goals of the compensatory mitigation needed for the LSJR Project. Specifically, the Franks Tract Futures project would create many acres of needed habitat within the correct regions (Table 15). Habitat created would be suitable for both Delta Smelt and all NMFS listed species. Habitat estimates are as follows:

Table 15- Restoration Possibilities at Franks Tract

Restoration Quantity	Preferred Concept
Marsh Area (acres)	1,370 acres
Recreational Use (acres)	12 acres
Fill to Grade (CY)	25,834,000
Consolidation (CY)	11,401,000
Total Fill/ Dredging (CY)	37,235,000
Habitat Preservation	**Preferred Concept**
Shallow Water Habitat	1,900 acres
Open Water Habitat	1,000 acres

Figure 1: Proposed Franks Tract Futures Project

Recreation is not an authorized purpose of the LSJR Project, therefore the LSJR Project would not need all of the mitigation acres the Franks Tract project would create. Any partnership effort would need align with the LSJR Project's authorization provided by Congress. It is likely that if selected, the LSJR Project would fund construction of a portion of the Franks Tract Futures project, sufficient to meet the mitigation needs of the LSJR Project. Consequently, the cost estimates associated with the Franks Tract partnership are extremely conservative.

Franks Tract is currently at the "concept" or 10% level of design. Based on this, if USACE proceeded with Option 7, it is estimated that the project could be completed in 5-12 years based on design and construction estimates from the Franks Tract Futures document.

- <u>Option 8- No Action Option.</u> Under this scenario no mitigation work would be performed, and the structure, functions and values of LSJR Project impacted habitats would be permanently lost. The option is retained for purposes of a baseline comparison against other action options.

Table 16, below, assesses each option based solely on its ability to meet the needs of the LSJR Project in full. Water resources law and policy requires in-basin and in-kind mitigation, in most cases. This screening level analysis is considered a go-no-go analysis to eliminate option that would not meet the needs of the LSJR Project. This analysis does not consider costs or comparison criteria at this phase to determine which plan is more preferable.

Table 16- Initial Screening of Mitigation Options

Option	Provides Riparian Habitat?	Provides Wetland Habitat?	Provides SRA Habitat?	Provides GGS Habitat?	Provides VELB Habitat?	Provides Delta Smelt Habitat?	Provides NMFS Fish Habitat?	Sufficient sites/credits available for full LSJR Project needs?
1. Bank Credits Alone	No	Yes	No	Yes	Yes	No	No	No
2. In-lieu Fee Alone	No	Yes	No	No	No	No	No	No
3. Construction Alone	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
4. Combination of Bank Credits and Construction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes[3]
5. Combination of In-lieu Fee and Construction	Yes	Yes	Yes	Yes	Yes	Yes	Yes	No
6. Rock Removal	Yes	Yes	Yes	No	No	Yes	Yes	No
7. Combination of Partnership and Bank Credits	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
8. No Action	No	No	No	No	No	No	No	No

[3] Because credit availability fluctuates throughout the year, USACE will provide an annual update on credit availability and outlook at on-going mitigation meetings during the first quarter of each fiscal year.

Based on the screening criteria, the following options have been carried forward:

- Option 4- Combination bank credits and construction
- Option 7- Combination of Partnership and Bank Credits

Option 1 was eliminated from further consideration since there are not sufficient habitat credits to meet the needs of the LSJR Project. Option 2 was eliminated from further consideration since there are no existing program types to cover the required species and habitat types required to meet the needs of the LSJR Project. Option 3 was eliminated to grant the government the flexibility to use credits, and credits have already been purchased in support of the LSJR Project. Option 4 was carried forward. Option 5 was eliminated since there are no existing programs which cover needed resources in the watershed, and existing cost estimates were over 10 years old, and therefore, the option was too speculative to carry forward. Option 6 was eliminated since no feasible sites could be identified to implement the mitigation. However, opportunities to employ Measure 7 – remove rock to restore shaded riverine aquatic habitat – would be sought at sites identified as suitable for mitigation construction. Option 7 was carried forward. Option 8 would be contrary to law and policy and is provided only as a comparison.

Option 4 would allow a combination of any of the potential mitigation projects 3A-3I to be constructed, along with acquiring available mitigation bank credits when needed. Option 4 would meet the mitigation objectives for all habitat types in a cost-efficient manner. Some loss of cost efficiency could occur where credit purchases are made in order to meet construction timelines for levee improvements. However, cost savings associated with keeping the overall LSJR Project on schedule would likely reduce these cost inefficiencies. In addition, carrying forward Option 4 allows the greatest flexibility for the LSJR Project. Option 7 was carried forward since it has the greatest opportunity to meet the mitigation needs for the NMFS Listed Species, which may not be fully met with the other options, depending on the mitigation ratio and the amount of habitat impacted. Purchase of mitigation bank credits for other species and habitat types could meet the rest of the requirements.

Several agencies, including USFWS, NMFS, EPA, and CDFW, have been participating in the mitigation planning process in support of this project. These agencies have been provided an opportunity to submit comments and request revisions to the options discussed in this document. "Agency submitted mitigation plans", options, and changes are included in Table 17. Finally, since compensatory mitigation would mitigate for losses to species listed under the ESA, the USFWS and NMFS have statutory authority under the ESA (PL 93-205) to make recommendations pertaining to mitigation. These recommendations are typically included in the biological opinions governing the LSJR Project. NMFS has additional authority under the Magnuson-Stevens Fishery Conservation and Management Act (PL 94-265) to make recommendations pertaining to essential fish habitat (EFH). Recommendations pertaining to EFH would also be included in the final version of this document. Lastly, if additional updates are made to the coordination act report, those recommendations would also be integrated into the final version of this plan.

Table 17- Summary of Agency Recommend Mitigation Plans and Measures

Agency	Mitigation Recommendation	Applicable Law	Adopted by Corps of Engineers?
USFWS	*Endangered Species Act Compensatory Mitigation Policy Appendix 1, 501 FW 3*	Endangered Species Act (Public Law 93-205)	*Incorporate Compensatory Mitigation Standards as applicable.*
USFWS	*Mitigation Policy Appendix 1, 501 FW 2*	Fish and Wildlife Coordination Act	*Apply Mitigation Framework, as applicable*
NMFS		Magnuson- Stevens Fishery Conservation and Management Act (Public Law 94-265)	
NMFS		Endangered Species Act (Public Law 93-205)	
EPA	The Delta is an important ecosystem for many Tribal communities along the San Joaquin River, Calaveras River, Fourteenmile Slough, Tenmile Slough, and Mosher Slough. Recommend conducting outreach with Tribal communities (i.e., Miwok, Yokut) to incorporate tribal beneficial uses and ancestral land management into the restoration process of the LSJR Project and proposed mitigation sites. Traditional Ecological Knowledge perspectives can encourage more integrative and ethical restoration that will benefit present-day tribal and non-tribal communities.	Executive Order 13175 and Memorandum on Uniform Standards for Tribal Consultation	USACE will coordinate and consult with tribes through cultural resources staff and tribal liaison to incorporate tribal input when provided.

10. Costs of Mitigation Plan Increments and Options

Cost estimates were prepared for each option. The team used various information sources to estimate the costs of the options. Available information included records of recent mitigation bank credit and in-lieu fee program credit sales and details from recently completed nearby ecosystem projects. The study team also considered other cost factors such as site access, fuel and equipment, and the availability of plant materials. Table 18displays the costs and outputs for each option plan.

Table 18- Estimated Costs of Option Plans

Options	Cost	Plan Outputs
No Action	$0	0
Option 4- Combination bank credits and construction		
GGS Bank Credits	$333,000	3.7 acres
NMFS Listed Fish Credits	$940,000	3.02 credits (1,589 LF)
Delta Smelt	$3,820,000	17 credits shallow water 2.1 credits open water
Construction on 3a, 3b, 3c, 3d, 3e, 3f, 3g	$139,786,089	413 acres -Riparian 49 acres-Wetland 49 acres -GGS 413 acres-VELB 50,600 LF-NMFS Listed Fish
Total Cost	**$144,879,089**	

Notes: *3.7 acres of GGS credits purchased in support of TS-30L to meet project schedule*

Option 7- Combination of construction, bank credits and partnership		
GGS Bank Credits	$228,800	2.86 acres
VELB Credits	$44,000	8 credits
Riparian Credits	$82,600,000	401 credits
Wetland Credits	$61,297	0.6 credits
Franks Tract Partnership	$150,130,208	58,890 – 103,686 LF SRA 12 acres Riparian 19.1 acres Delta Smelt Habitat
Total Cost	**$233,064,305**	

Notes: Combinations of options were determined based on meeting the mitigation needs of the project. Combinations which did not meet the objective were not considered. The "3h" contingency parcel was not included in cost estimate comparisons due to uncertainty.

Option Plan–4, combination bank credits and construction provides full mitigation of losses specified in the planning objectives with a margin of error. Since the plan is modular, consisting of several smaller sites rather than a single large site, if mitigation objectives are completed prior to build out and acquisition of all sites, costs could decrease as all sites may not be necessary. Option Plan 7, combination of construction, bank credits, and partnership also provides full mitigation of losses specified in the planning objectives but is more costly than Option 4.

11. Plan Selection Considerations

The least cost plan may not be the recommended plan when other selection factors or tradeoffs are considered. Therefore, all options carried forward have been compared to each other against the Plan Comparison Criteria (Table 19). These criteria are primarily targeted at determining which option is most likely to meet the mitigation objective, and thereby carries the lowest risk. Table 19 assesses each option plan by posing and answering a set of questions aimed at discerning differences in options beyond simply identifying the least cost plan. Questions and rationale are as follows:

Acquisition prior to construction?
Section 906 of WRDA 1986, as amended by Section 1040 of WRRDA 2014 and Section 1162 of WRDA 2016. Fish and Wildlife Mitigation requires mitigation work to be performed before or concurrently with project construction.

In addition, USFWS Mitigation Policy (2023) states as follows, "*Advance compensatory mitigation*. When compensatory mitigation is necessary, the Service prefers compensatory mitigation measures that are implemented in advance of project impacts." In addition, in the most recent consultation with USFWS, USFWS recommended as a conservation measure that mitigation be completed 1-year in advance of impact.

Therefore, those options which can be implemented most expeditiously are the most preferable.

Large contiguous tract?
Large contiguous parcels are more likely to be successful than small parcels, as a primary driver in species decline is habitat loss and fragmentation Jaureguiberry et.al., 2022(). However, consolidation of too much dispersed habitat can have deleterious effects as well.

Can the mitigation be acquired in fee?
For private parcels, USACE Real Estate policy required that mitigation lands be acquired in fee. This stipulation does not apply to publicly held parcels, but requires a policy deviation, approved at the HQUSACE, which can take up to 2 years.

Can a conservation easement be obtained?
For publicly held parcels, a conservation easement may be required to ensure that the use of the land does not change in the future. Memorandums of agreement could also be used, however, there is greater risk in option arrangements, which may require higher levels of approval.

Relative distance from project site?
Since many of the target species are diminutive in size, they have a limited dispersal capability, therefore those parcels which are closest to the area of impact are most likely to benefit the individuals directly affected by the action.

Proximity to source populations?
A nearby source population helps ensure that the habitat created will be utilized by the target species.

Habitat connectivity?
Increasing fragmentation of habitat reduces the chances that species can breed or disperse, therefore parcels that increase, maintain, or create connectivity are highly desirable.

Sustainability with respect to climate change and maintenance?
Sites which are less likely to be inundated by sea level rise, and those with lower maintenance requirements are more likely to be successful in the long run.

Specific risks or considerations?
There are differences in risks between the options. Additional risks for consideration have been listed.

Additional benefits (ecosystem services)
While not a criterion for selection, a factor for consideration in site selection and design will be the potential for maximization of ecosystem services. Sites that could reasonably maximize ancillary benefits such as recreational opportunities, improvements in water quality, pollination services, noise attenuation, air quality improvement, and psychological green space benefits will be prioritized over those sites which do not provide these benefits, all other criteria held equal. In all cases, any sites designed, would include features to maximize these benefits.

Table 19- Comparison of the Options

OPTION	COMPARISON CRITERIA							
	Acquisition prior to construction[1]?	**Large contiguous tract[2]?**	**Can the mitigation be acquired in fee?**	**Can a conservation easement be obtained**	**Relative distance from project site**	**Proximity to source populations**	**Habitat connectivity**	**Sustainability with respect to climate change and maintenance**	**Specific risks or considerations**
4. Combination bank credits and construction	Yes.	Yes, depending on construction chosen	All privately owned parcels can be acquired in fee.	Publicly owned parcels would require a conservatio n easement	Some parcels are close, others are moderate, Manteca is distant.	Close	Provides connectivity[5]	3 parcels are vulnerable to sea level rise, However, these sites could continue to serve as SRA and shallow water habitat.	Private parcels could sell prior the government being able to complete the purchase.
7. Partnership	Unknown.	Yes	No. Public Parcel. Conservation Easement required	Yes	Distant	Close	Provides connectivity[5]	Yes. Feasibility study has considered sea level rise and O&M.	Timeline of partners is uncertain if the USACE cannot fund in full

Notes:
Color scheme- Green- low risk or ideal characteristic; amber- risk present, can be bought down with additional data; red- unmitigable risk or undesired characteristic; purple – not applicable
1-A large tract was defined as one greater than or equal to 100 acres. Parcels greater than 100 acres are generally very effective habitat as a mosaic of habitat types can be established
2- Close is 0-5 miles; Moderate is 5-10 miles; Distant is greater than 10 miles
3- Adjacent means it directly connects to another habitat area with no gap
4- Provides connectivity means it links two or more existing habitat areas

12. Recommended Compensatory Mitigation Plan

Based upon these considerations Option 4 – the purchase of mitigation bank credits in combination with construction of mitigation sites is the lowest risk plan, the least cost plan, and meets the mitigation needs for the LSJR Project in full. Table 20 outlines the specific planned parcels that will meet the needs of the LSJR Project.

Due to the limited number of parcels available for use as compensation sites, and the high mitigation needs for the LSJR Project, all available sites are planned for construction at the time of this draft plan.

Parcels which can be acquired in fee from willing sellers will be prioritized for construction first. Publicly held parcels require a lengthier acquisition process and would likely be constructed later.

The combination of these parcels plus the purchase of credits, where available meets, all the needs of the LSJR Project and contains a margin for error. If compensation needs are satisfied prior to buildout of all sites, not all sites would be constructed. The sequencing for planned sites is found in Appendix E. In addition, on-site compensation opportunities would be explored whenever available, provided the flood risk reduction measures are not affected. If impacts exceed the high estimate due to unforeseen circumstances, additional mitigation parcels, referred to as "3h" in this document would need to be acquired. This would increase estimated costs and the plan would be revised and updated accordingly. As designs of each phase of the LSJR Project are refined, USACE will continue to coordinate with the resource agencies to ensure that project impacts are sufficiently compensated. Additional parcels conducive to mitigation construction may be identified after the publication of this plan and could be constructed under "3h – unidentified parcels."

Constructing mitigation work versus purchasing mitigation credits carries risks of project non-performance that would have to be addressed by additional work at government expense. Retaining the flexibility to purchase credits as needed, where available, helps to mitigate this risk.

Table 20- Recommended Plan Rationale

Species/ Habitat	Acres Required	Planned Mitigation Option (s)	Mitigation Provided	Rationale
Giant Garter Snake	1.5 acres aquatic habitat	Construct 3a	1.5 acres of wetland	Credits for this species are readily available. However, aquatic habitat requirements for GGS overlap with wetland and potentially shallow water habitat types. Therefore, it is more cost effective for the government to integrate GGS aquatic habitat into the design of a constructed mitigation site.
	12.5 acres upland habitat	Purchase Bank Credits and Construct 3a	12.5 acres	Credits for this species are readily available. However, upland habitat requirements for GGS could be easily integrated into difficult to use segments of land including under transmission lines, on berms and other areas where large woody vegetation is precluded. Therefore, it is more cost effective for the government to integrate GGS upland habitat into the design of a constructed mitigation site.
	55.75 acres temporary	On-site restoration	55.75 acres	Provided all construction can be completed in a single season, compensatory mitigation should not be required.
Delta Smelt	17 credits- shallow water 2.1 credits- open water	Bank Credits	17 credits shallow water, 2.1 credits open water	Per existing BO
VELB	403.5 acres*	Construct 3a	65 acres	Elderberry habitat is a subset of riparian habitat, and riparian habitat must already be constructed, it is more cost effective for the government to integrate elderberry plantings into a planned riparian mitigation site. Properties currently available meet the high range of the mitigation need.
		Construct 3b	20 acres	
		Construct 3c	41 acres	
		Construct 3d	27 acres	
		Construct 3e	145 acres	
		Construct 3f	40 acres	
		Construct 3g	70 acres	
NMFS Listed Fish	58,890 – 103,686 linear feet	Bank Credits	2,600 LF	Limited parcels were able to support SRA due to the need for river adjacency. Suitable parcels either required a setback or no existing levee. All parcels which offered SRA were used. Current combination of bank credit purchases and construction of sites places available mitigation within the planned range.
		Construct 3b	15,000 LF	
		Construct 3d	9,600 LF	
		Construct 3f	11,000 LF	
		Construct 3g	15,000 LF	

Species/ Habitat	**Acres Required**	**Planned Mitigation Option (s)**	**Mitigation Provided**	**Rationale**
Riparian Habitat	72.1 AAHU (72.1 -417 acres)	Construct 3a	65 acres	Sufficient land for riparian habitat is readily available. The parcels selected were those which had the greatest ability for habitat stacking, (i.e., could the riparian also serve as SRA or VELB habitat). Habitat stacking ensures the greatest cost effectiveness for the government and creates complex habitat. Properties currently available meet the high range of the mitigation need.
		Construct 3b	20 acres	
		Construct 3c	41 acres	
		Construct 3d	27 acres	
		Construct 3e	145 acres	
		Construct 3f	40 acres	
		Construct 3g	70 acres	
Wetland Habitat	10.75 AAHU (7.68-32.25 acres)	Construct 3a	7 acres	While credits are available for wetlands, this habitat type is easily integrated into hard to use places of other constructed mitigation sites. Therefore, it is more cost effective for the government to integrate this habitat rather than buying single purpose credits.
		Construct 3d	3.39+acres	

Notes: + indicates excess acres as designed

* This value is an upper limit maximum. The exact amount required will depend on the number of reaches containing elderberry in riparian habitat.

13. Implementation Risks

All mitigation projects carry risks. Assessing risks across phases of project implementation assists in identifying risk management measures. The likelihood that a risk may be realized, and the magnitude of a risk's impact are additional considerations that can help inform decisions. Table 21 summarizes foreseeable implementation risk factors across each phase of implementation (Pre-Construction Engineering and Design, Construction, and Operations). These factors are based upon experience from similar projects and the consideration of regional risks generally associated with design and construction work in wet environments. Each risk was assessed and assigned a significance level. Potential risk management measures were identified and will be considered should the need arise during implementation or adaptive management.

Table 21- Summary of Implementation Risks for Constructed Projects

Acquisition Risks			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Acquisition cost higher than projected	High	Medium	The cost of land in California rises rapidly and rarely decreases. Acquisition of suitable properties should occur as soon as possible to avoid escalation. In addition, having contingency properties increases options in the event a price increases too high.
Target parcels become unavailable	Medium	Medium	Land sells rapidly in California. Once suitable properties are identified, project team will assess the schedule for acquisition, including any required soil testing.
Credits no longer available to purchase	High	Medium	Many projects are competing for the same credits. In addition, the Federal government does not have a mechanism to reserve credits due to the contracting process.
Pre-Construction Engineering and Design Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Increase in habitat impacts	Medium	Medium	Include mitigation sequence commitments in Plans and Specification development. Employ Best Management Practices in Plans and Specifications. Confirm during Biddability, Constructability, Operability, and Environmental Sustainability review.
Poor soil conditions	Low	High	Address through design considerations. Inability to address could lead to change in mitigation site or plan.
Construction Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Excessive rainfall or flooding	Medium	Medium	Plan for construction during more favorable weather seasons. Anticipate weather events before initiating weather-dependent phases of construction. Use appropriate equipment for site conditions.

Construction management	Low	Low	Monitor use of Best Management Practices during construction work. Confirm construction as-built requirements are met. Document all conditions pre- and post-construction at site.
Operations Phase			
Risk Factor	**Risk Potential**	**Risk Rating**	**Risk Management Measures**
Storm impacts to mitigation	Varies	Medium	Incorporate engineering with nature elements into mitigation design. Develop a storm impact assessment and response plan. Employ adaptive management measures to address impacts that prevent the achievement of ecological success criteria.
Human impacts to mitigation	High	High	Unhoused individuals regularly utilize public lands for shelter which could be to the detriment of mitigation sites. Vandalism or refuse dumping could also occur by other groups. To mitigate the risk of human impacts, the NFS should develop informational signage for placement on the sites and engage with local land stewardship groups and the local community to help care for the sites. Human impact control could be a condition of mitigation acceptance. Adaptive management may need to be conducted throughout the project to ensure habitat value is retained. Where appropriate, defensive architecture and landscaping techniques could be used.
Contractor performance risk	Low	Low	Contractor could fail to care for site in accordance with requirements causing the mitigation site to not meet ecological success criteria. However, if this were to occur, USACE would file a claim against the contractor who would be financially liable for losses. In addition, the contractor surveillance program at USACE makes this risk less likely.

14. Ecological Success Criteria

Ecological success criteria have been identified for each habitat type that requires compensatory mitigation in Table 22. The criteria were selected based upon a review of scientific literature related to these types of habitats and this area. Wetland and riparian habitat criteria were largely defined utilizing the assessment metrics from the California Rapid Assessment Method (CRAM) version 6.1. (San Francisco Estuary Institute, 2013a and 2013b). Metrics which are outside of the control of USACE, such as landscape level assessments of connectivity and hydrologic sources, were not included, despite the benefit to species that these attributes may provide. Specific targets for soil success criteria were derived from averages achieved on other wetland/riparian restorations, with 50-year target metrics similar to natural (or reference[4]) sites. Success criteria for ESA listed species were derived from the recovery plans for each species and relevant scientific literature. Specific metrics are identified and quantified along with time periods for meeting the metric.

[4] A reference site is a place which possesses desired ecological characteristics, whether those characteristics are naturally occurring or are the result of a previous restoration or enhancement effort.

Prior to construction of each mitigation parcel, USACE would conduct an assessment of ecological function and condition. USACE would use CRAM methodology to assess the both the pre and post project condition of wetland habitats. HEP analysis would be used to inform the condition of Riparian and Grassland habitats. Mitigation ratios have been established for some species within the biological opinions governing the LSJR Project, however, where this is not the case, USACE will consult with USFWS and NMFS as appropriate to determine acceptable compensation ratios.

Table 22- Ecological Success Criteria

Habitat	Riparian	Wetland
Objective		
Buffer Condition	Year 1- Buffer habitat, generally defined as the levee crown, slopes, and operations and maintenance corridor, with less than 50% cover invasive species, no human settlements or refuse. Year 2- Buffer habitat, as defined by the property extent, with less than 25% cover invasive species, no human settlements or refuse. Year 3- Buffer habitat, as defined by the property extent, with less than 10% cover invasive species, no human settlements or refuse. Year 5- Buffer habitat, as defined by the property extent, with no invasive species, no human settlements or refuse. Year 10+ Buffer habitat, as defined by the property extent, in with less than 25% cover invasive species, no human settlements or refuse.	Year 1- Buffer habitat, as defined by the property extent, with less than 50% cover invasive species, no human settlements or refuse. Year 2- Buffer habitat, as defined by the property extent, with less than 25% cover invasive species, no human settlements or refuse. Year 3- Buffer habitat, as defined by the property extent, with less than 10% cover invasive species, no human settlements or refuse. Year 5- Buffer habitat, as defined by the property extent, with no invasive species, no human settlements or refuse. Year 10+ Buffer habitat, as defined by the property extent, in with less than 25% cover invasive species, no human settlements or refuse.
Soils	Year 1-Accumulation of leaf litter debris across 5% of ground surface area Year 2- Accumulation and decay of leaf litter debris across 20% of ground surface area Year 3-Achieve a measurable significant increase in soil organic matter (SOM) and total carbon from base sample collected at Year 0 Year 5-Show an increase of 120 gC/m^2 from the base value Year 10- Show an average increase of 240 $gC/m^2/y$ from the base value; Achieve SOM of 5% in the top 5cm of the soil Year 25- Show an average increase of 280 $gC/m^2/y$ from the base value, Achieve SOM of 8% in the top 5cm of the soil Year 50- Show an average increase of 300 $gC/m^2/y$ from the base value, Achieve SOM of 10% in the top 5cm of the soil	Year 1-Accumulation of detritus in 20% of water bodies Year 2-Accumulation of detritus in 50% of water bodies Year 3- Achieve a measurable significant increase in soil organic matter (SOM) and total carbon from reference sample Year 5-Show an increase of 240 gC/m^2 from the reference value Year 10- Show an average increase of 375 $gC/m^2/y$ from the base value; Achieve SOM of 5% in the top 10cm of the soil Year 25- Show an average increase of 375 $gC/m^2/y$ from the base value, Achieve SOM of 10% in the top 10cm of the soil Year 50- Show an average increase of 375 $gC/m^2/y$ from the base value, Achieve SOM of 15% in the top 10cm of the soil
Hydrology and Physical Structure	Year 1-4- Irrigation provided Year 5- Achieve a structural patch richness of 3 Year 10- Achieve a structural patch richness of 4-5 Year 25- Achieve a structural patch richness of 6-7 Year 50- Achieve a structural patch richness of ≥8	Year 1-3- Irrigation provided; wetland areas holding precipitation as shown by saturation for 72 hours post precipitation event Year 4- Precipitation provides 10% of water in the site. Site not reliant solely on irrigation for function. Year 5- Precipitation provides 20% of water in the site. Site not reliant solely on irrigation for function. Year 10- Hydroperiod is characterized by mostly natural patterns of filling or inundation, and drying or drawdown, as compared to average of minimum of 5 reference sites; characteristics within 10% of reference site Year 25-Soil saturation of adjacent areas in mitigation site for 50-90% of the perimeter during the wet season Year 50- Transition zones between wetland areas and other habitats fully developed, evidence of seasonal flooding evident.

Vegetation Characteristics	**Year 1**		**Year 1**	
	Number of plant layers	1	Number of plant layers	1
	Number of Co-dominant species	1	Number of Co-dominant species	1
	Vertical Spatial Complexity	Two plant layers present on 25% of the site	Vertical Spatial Complexity	10% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 2		**Year 2**	
	Number of plant layers	1	Number of plant layers	1 across 50% of area
	Number of Co-dominant species	2	Number of Co-dominant species	2
	Vertical Spatial Complexity	Two moderately overlapping plant layers on 10-25% of the site	Vertical Spatial Complexity	15% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 3		**Year 3**	
	Number of plant layers	1	Number of plant layers	1 across 75% of area
	Number of Co-dominant species	3	Number of Co-dominant species	3
	Vertical Spatial Complexity	Two moderately overlapping plant layers on 25%-50% of the site	Vertical Spatial Complexity	25% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 5		**Year 5**	
	Number of plant layers	2	Number of plant layers	2 across 25% of area
	Number of Co-dominant species	4	Number of Co-dominant species	4
	Vertical Spatial Complexity	Two moderately overlapping plant layers on greater than 50% of the site	Vertical Spatial Complexity	25%-50% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 10		**Year 10**	
	Number of plant layers	2	Number of plant layers	2 across 50% of area
	Number of Co-dominant species	5-7	Number of Co-dominant species	5-6
	Vertical Spatial Complexity	Three moderately overlapping plant layers on 10%-25% of the site	Vertical Spatial Complexity	≥50% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 25		**Year 25**	
	Number of plant layers	3	Number of plant layers	3 across 25% of area
	Number of Co-dominant species	8-10	Number of Co-dominant species	7-8
	Vertical Spatial Complexity	Three moderately overlapping plant layers on 25%-50% of the site	Vertical Spatial Complexity	≥50% of the area has canopy of living vegetation or entrained litter or detritus.
	Year 50		**Year 50**	
	Number of plant layers	4	Number of plant layers	4-5 across 25% of area
	Number of Co-dominant species	≥ 11	Number of Co-dominant species	9
	Vertical Spatial Complexity	Three moderately overlapping plant layers on more than 50% of the site	Vertical Spatial Complexity	≥50% of the area has canopy of living vegetation or entrained litter or detritus.

Habitat Objective	Giant Garter Snake	Valley Elderberry Longhorn Beetle
Food/Forage availability	Year 1-Stock aquatic habitat with Sierran Tree Frog eggs, tadpoles. Year 2- Stock aquatic habitat with Sierran Tree Frog eggs, tadpoles. Year 3-Achieve naturally reproducing Sierran Tree Frog population as evidenced by presence of eggs or tadpoles that were not stocked. Year 5- Site exhibits at least two species of recognized GGS food Year 10+ Site exhibits at least three species of recognized GGS food	Year 1-Survival of 75% of transplanted elderberry shrubs Year 2-Survival of 75% of transplanted shrubs, and 50% of planted seedlings Year 3- 50% of surviving transplanted shrubs flowering/fruiting; 25% of seedlings have stems greater than 1 inch in diameter Year 5-75% of surviving transplanted shrubs flowering/fruiting, 50% of seedlings have stems greater than 1 inch in diameter Year 10-75% of planted elderberry with at least 1 stem greater that 1 inch in diameter per plant Year 25-Elderberry codominant in mid-to-understory layer with associated riparian species; evidence of natural reproduction via new seedlings, suckering Year 50- Elderberry codominant in mid-to-understory layer with associated riparian species; evidence of natural reproduction via new seedlings, suckering, and a variety of age classes throughout the site
Shelter	Year 1- Established standing or slow water habitat of at least 1 m in width inundated to a depth of 10 cm. Year 2- Established standing or slow water habitat of at least 1 m in width inundated to a depth of 10 cm for 30% of the time from May 1-September 15. Year 3- Established standing or slow water habitat of at least 1 m in width inundated to a depth of 10 cm for 50% of the time from May 1-September 15. Year 5- Established standing or slow water habitat of at least 1 m in width inundated to a depth of 10 cm for 75% of the time from May 1-September 15 with 5% cover of emergent wetland plants. Year 10+ Established standing or slow water habitat of at least 1 m in width inundated to a depth of 10 cm for 75% of the time from May 1-September 15 with 20% cover of emergent wetland plants and naturally occurring burrows within 200 feet.	
Presence* *Note: presence surveys will be performed, however, absence of species will only be used to inform future mitigation designs, but absences is not considered a failure of the mitigation	Year 5- Conduct trapping surveys to determine presence of GGS on the mitigation site Year 10- Trapping surveys indicate presence of one GGS on the mitigation site Year 50-Evidence of breeding on the site	Year 1-Transplant shrubs with existing exit holes Year 2- Ensure 75% of transplants survive Year 3- 25% of seedlings have stems greater than 1 inch in diameter Year 5- 50% of seedlings have stems greater than 1 inch in diameter Year 10- Exit holes present on planted shrubs Year 50- Flight surveys indicate positive species presence

Habitat Objective	Delta Smelt	NMFS Listed Fish Species
Food/Forage availability	Year 1-Calanoid copepods density of 200 µgC m^3 Year 2- Calanoid copepods density of 500 µgC m^3 Year 3- Calanoid copepods density of 1000 µgC m^3 Year 5- Calanoid copepods density of 1500 µgC m^3 Year 10- Calanoid copepods density of 3000 µgC m^3 Year 25- Calanoid copepods density of 5000 µgC m^3 Year 50- Calanoid copepods density of 8500 µgC m^3	Year 1-Benthic invertebrate abundance $100/m^2$ across 5 taxa, drift invertebrate abundance of $0.1/m^3$ across 3 taxa Year 2- Invertebrate abundance $200/m^2$ across 5 taxa, drift invertebrate abundance of $0.4/m^3$ across 3 taxa Year 3- Invertebrate abundance $500/m^2$ across 5 taxa, drift invertebrate abundance of $0.8/m^3$ across 3 taxa Year 5- Invertebrate abundance $650/m^2$ across 5 taxa, drift invertebrate abundance of $1.2/m^3$ across 3 taxa Year 10- Invertebrate abundance $900/m^2$ across 10 taxa, drift invertebrate abundance of $1.5/m^3$ across 5 taxa Year 25- Invertebrate abundance $950/m^2$ across 10 taxa, drift invertebrate abundance of $1.5/m^3$ across 5 taxa Year 50- Invertebrate abundance $\geq 1000/m^2$ across 10 taxa, drift invertebrate abundance of $1.5/m^3$ across 5 taxa
Shelter	Year 1-Establishment of dendritic blind channels with at least three orders. Year 2- Herbaceous vegetation present on banklines of dendritic blind channels along 20% of length in accordance with monitoring protocol. Year 3- Herbaceous vegetation present on banklines of dendritic blind channels along 50% of length. Turbidity levels in channels between 10 NTU and 80 NTU, water depth 4-8 meters. Year 5- Herbaceous vegetation present on banklines of dendritic blind channels along 50% of length. Turbidity levels in channels between 10 NTU and 80 NTU, banklines actively eroding along 5% of channel lengths, water depth 4-8 meters. Year 10+ Herbaceous vegetation present on banklines of dendritic blind channels along 50% of length. Turbidity levels in channels between 10 NTU and 80 NTU, banklines actively eroding along 5% of channel lengths, water depth 4-8 meters, channels free of non-native SAV	Year 1-Establishment of riparian vegetation Year 2- Total coverage of 50% of bankline with riparian vegetation, with 10% woody vegetation minimum and 5% in channel emergent vegetation Year 3- Total coverage of 75% of bankline with riparian vegetation, with 20% woody vegetation minimum and 10% of bankline in channel emergent vegetation Year 5- Total coverage of 75% of bankline with riparian vegetation, with 25% woody vegetation minimum and 10% of bankline in channel emergent vegetation Year 10-Undercutting of bankline with exposed roots or vegetation overhanging the water along 25% of bankline Year 25+ Undercutting of bankline with exposed roots or vegetation overhanging the water along 40% of bankline, large wood naturally recruited into channel
Presence	<<Precluded due to very low levels of smelt, may reassess in the future>>	Year 1, 3, 5, 10, 50- Conduct fish telemetry survey, positive presence of juvenile species of interest

15. Monitoring and Adaptive Management

An individual Habitat Monitoring and Adaptive Management Plan (HMAMP) will be developed for each constructed mitigation site and included as an appendix in the environmental document for the levee improvement. Relevant sections of this HMAMP will then be integrated into the site's operation and maintenance manual, as appropriate. This approach will allow specificity as each site will be slightly different. Nonetheless, certain tasks will be common to sites based on the habitat type included in the mitigation site. Table 23 includes a summary of the cost, based on a 100-acre site, and duration of monitoring work and identifies the entity that will be responsible for the monitoring activity. While the costs should be assumed to be per site, there may be some efficiencies gained by conducting a suite of sites simultaneously, thereby reducing costs. The elements of the monitoring plan are designed to measure the attainment of ecological success criteria at key points over the course of the mitigation construction and operation periods. The costs of monitoring activities prior to, during construction, and the establishment period until ecological success is achieved, are cost shared. After the ecological success period, the NFS will be responsible for the on-going monitoring and maintenance of the site in perpetuity.

Table 23- Monitoring Activities

Years	Activity	Data	Cost	Responsible Entity
-1	Pre-construction surveys	Soils, buffer, vegetation, wildlife, baseline data	$20,000	USACE and Non- Federal Sponsor
0	Construction monitoring	Confirm implementation of avoidance measures	$15,000	
1	As-Built Surveys and Construction Completion Report	Confirm project is built to Plans and Specifications	Construction Cost	USACE and contractor
1-5	General assessment of buffer areas	Adverse human impacts to mitigation sites	$5,000	USACE and Non- Federal Sponsor
	Soils	Wetland and riparian habitat development	$15,000	
	Hydrology & Physical Structure	Assess structural development and integrity of created habitat	$15,000	
	GGS Food Survey	Assess availability of food for GGS	$10,000	
	GGS Aquatic Habitat Assessment	Assess quality of created habitat for GGS	$5,000	
	Elderberry Assessment Surveys	Assess suitability of created habitat and presence of VELB	$30,000	
	Delta Smelt Food Survey	Assess availability of food for Delta Smelt	$20,000	
	Delta Smelt Habitat Assessment	Assess quality of created habitat for Delta Smelt	$5,000	
	Aquatic food survey	Assess availability of food for NMFS listed fish species	$20,000	
	SRA Assessment	Assess quality of habitat for NMFS listed fish species	$5,000	
	Fish Telemetry	Assess presence of NMFS listed fish species	$175,000	
5	GGS Trapping Survey	Assess presence of GGS in created habitat	$30,000	

Years	Activity	Data	Cost	Responsible Entity
10	General condition assessment of buffer areas	Adverse human impacts to mitigation sites	$6,500	Non-Federal Sponsor
	Soils	Wetland and riparian habitat development	$18,500	
	Hydrology & Physical Structure	Assess structural development and integrity of created habitat	$18,500	
	GGS Food Survey	Assess availability of food for GGS	$12,500	
	GGS Aquatic Habitat Assessment	Assess quality of created habitat for GGS	$6,500	
	Elderberry Assessment Surveys	Assess suitability of habitat and presence of VELB in created habitat	$37,500	
	Delta Smelt Food Survey	Assess availability of food for Delta Smelt	$25,000	
	Delta Smelt Habitat Assessment	Assess quality of created habitat for Delta Smelt	$6,500	
	Aquatic food survey	Assess availability of food for NMFS listed fish species	$30,000	
	SRA Assessment	Assess quality of habitat for NMFS listed fish species	$6,500	
	Fish Telemetry	Assess presence of NMFS listed fish species	$220,000	
25	General condition assessment of buffer areas	Adverse human impacts to mitigation sites	$9,000	
	Soils	Wetland and riparian habitat development	$27,000	
50	Elderberry Flight Survey	Assess presence of VELB in created habitat	$55,000	
	GGS Trapping Survey	Assess presence of GGS in created habitat	$55,000	
	Fish Telemetry	Assess presence of NMFS listed fish species	$585,000	
50	Final monitoring report	Comprehensive report	$100,000	Non-Federal Sponsor

Periodic monitoring reports documenting the monitoring activities and the results will be prepared after each monitoring activity. For efficiency, results of monitoring activities may be aggregated into annual or other periodic reports. For example, if several monitoring activities are due at year 25, a single report would be shared for these activities. Similarly, if no monitoring activity is scheduled for year seven, no report would be submitted in year seven. Results will be shared with the USACE and interested resource agencies.

In addition, Section 906(d)(4) of WRDA 1986, as amended, requires the USACE Sacramento District to hold an annual mitigation consultation meeting with the appropriate Federal and State agencies. All mitigation projects constructed will be reviewed with a focus on the ecological success criteria, the likelihood that the project will achieve success, the timeline to achieve success, and any recommendations to improve the likelihood of success (33USC § 2283 (4)(B)). Once ecological success criteria are met, review of the project is no longer needed at the annual meeting.

Adaptive management plans are informed by project monitoring results. It is important that a science-based monitoring plan target the collection of performance information to help inform potential adaptive management actions. Adaptive management allows the project team to use monitoring feedback to make changes to project features or operations to improve attainment of ecological success criteria. This contingency plan (Table 24) outlines a range of corrective actions in cases where monitoring demonstrates that mitigation features are not achieving ecological success goals.

Table 24- Adaptive Management Actions

Element	Expected Condition	Potential Issue	Potential Corrective Action
Buffer Areas	Free of trash and other adverse human impacts with few to little invasive vegetative species coverage	Excess trash, weed invasion, human encampments, social trails	-Collect trash -Manage invasive species using approved methods -Contact law enforcement to clear camps -consider formalizing trails to prevent additional damage and place informational signage
Soils	Of sufficient quality to support wetland or riparian habitat	Low organic matter or carbon content, high bulk density	-Add wood chip, compost, or leaf litter debris to amend soils
Hydrology and Structure	Flows supportive of desired habitat type, creating scour and erosion where needed	Flows insufficient creating stagnant backwaters and sedimentation	-Adjust in channel grades as needed with large wood to create grade
Vegetation	Surviving, diversifying, and reproducing without human intervention	Vegetation homogenizing into few to single species dominance or not reproducing	-Assess sources of vegetative disturbance. Determine if additional sources of periodic disturbance are needed, such as grazing, fire, or flood regime.
Wildlife presence or use	Target species utilizing habitat	Insufficient food resources, excess human disturbance, or insufficient connectivity preclude habitat use	-Document the failure in the reports, determine potential root causes and share data to improve future habitat mitigation site designs. -Work with USFWS on development of a plan and required compliance to translocate local or captive reared species to mitigation sites to attempt to establish a colony.

16. References

Laws

- Clean Water Act (33 U.S.C. 1251 et seq)
- Endangered Species Act (16 U.S.C. 1531 et seq)
- Fish and Wildlife Coordination Act (16 U.S.C. 661-666c)
- Magnuson – Stevens Fishery Conservation and Management Act (16 U.S.C. 1801 et seq)
- National Environmental Policy Act (42 U.S.C. 4321 et seq.)
- Water Resources Development Acts of 1986 (PL 99-662), 1990 (PL 101-640), 2000 (PL 106-541), 2007(PL 110-114), 2014 (PL 113-121), and 2016 (PL 114-322).

Implementation Guidance

- Implementation Guidance for Section 2036(a) of the Water Resources Development Act of 2007 (WRDA 07) - Mitigation for Fish and Wildlife and Wetlands Losses. Issued by ASA(CW) 31 August 2009.
- Implementation Guidance for Section 1162 of the Water Resources Development Act of 2016 and Section 1040 of the Water Resources Reform and Development Act of 2014, Fish and Wildlife Mitigation (Section 906 of the Water Resources Development Act of 1986, as amended (33 U.S.C. 2283)) Issued by ASA(CW) 08 March 2019.
- Implementation Guidance for Section 1163 of the Water Resources Development Act of 2016, Wetlands Mitigation. Issued by ASA(CW) 08 March 2019.
- Implementation Guidance for Section 906 of WRDA 1986, as amended by Section 1040 of WRRDA 2014 and Section 1162 of WRDA 2016. Fish and Wildlife Mitigation. Issued 08 March 2019. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll5/id/35384
- Implementation Guidance for Section 906 of WRDA 1986 as amended by Section 2036(a) of WRDA 2007. Fish and Wildlife Mitigation. Issued 31 August 2009. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll5/id/386
- Implementation Guidance for Section 2036(c) of WRDA 2007, as amended by Section 1163 of WRDA 2016. Mitigation Banks and In-Lieu Fee Arrangements. Issued 08 March 2019. https://usace.contentdm.oclc.org/utils/getfile/collection/p16021coll5/id/35385
- Engineer Regulation 1105-2-100 Planning Guidance Notebook. Appendix C – Environmental Evaluation and Compliance

Policy

- Cost Sharing for Lands Associated with Fish and Wildlife Mitigation. Issued by USACE Director of Civil Works 19 September 2006.

Regulations

- 40 CFR 230.92, definition of mitigation bank.
- 40 CFR 1500.3(b)(2), include options input from State, Tribal and local governments.
- 40 CFR 1503.3(e), cooperating agencies must cite statutory authority to specify mitigation.
- 40 CFR 1508.5, definition of cooperating agency.
- 40 CFR 1508.20, definition of mitigation.
- Engineer Circular 1105-2-412 Assuring Quality of Planning Models.
- Engineer Regulation 1105-2-100 Planning Guidance Notebook, Appendix C.
- Engineer Regulation 200-1-5 Policy for Implementation and Integrated Application of the U.S.

Army Corps of Engineers (USACE) Environmental Operating Principles (EOP) and Doctrine.

- Engineer Regulation 200-2-2 Procedures for Implementing NEPA.

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Appendix A
Franks Tract Futures

FRANKS TRACT FUTURES 2020

reimagined

Options for enhancing navigation, recreation, ecology, and water quality in the central Delta

California Department of Fish and Wildlife

September 30, 2020

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Franks Tract Futures Project Website:

https://franks-tract-futures-ucdavis.hub.arcgis.com

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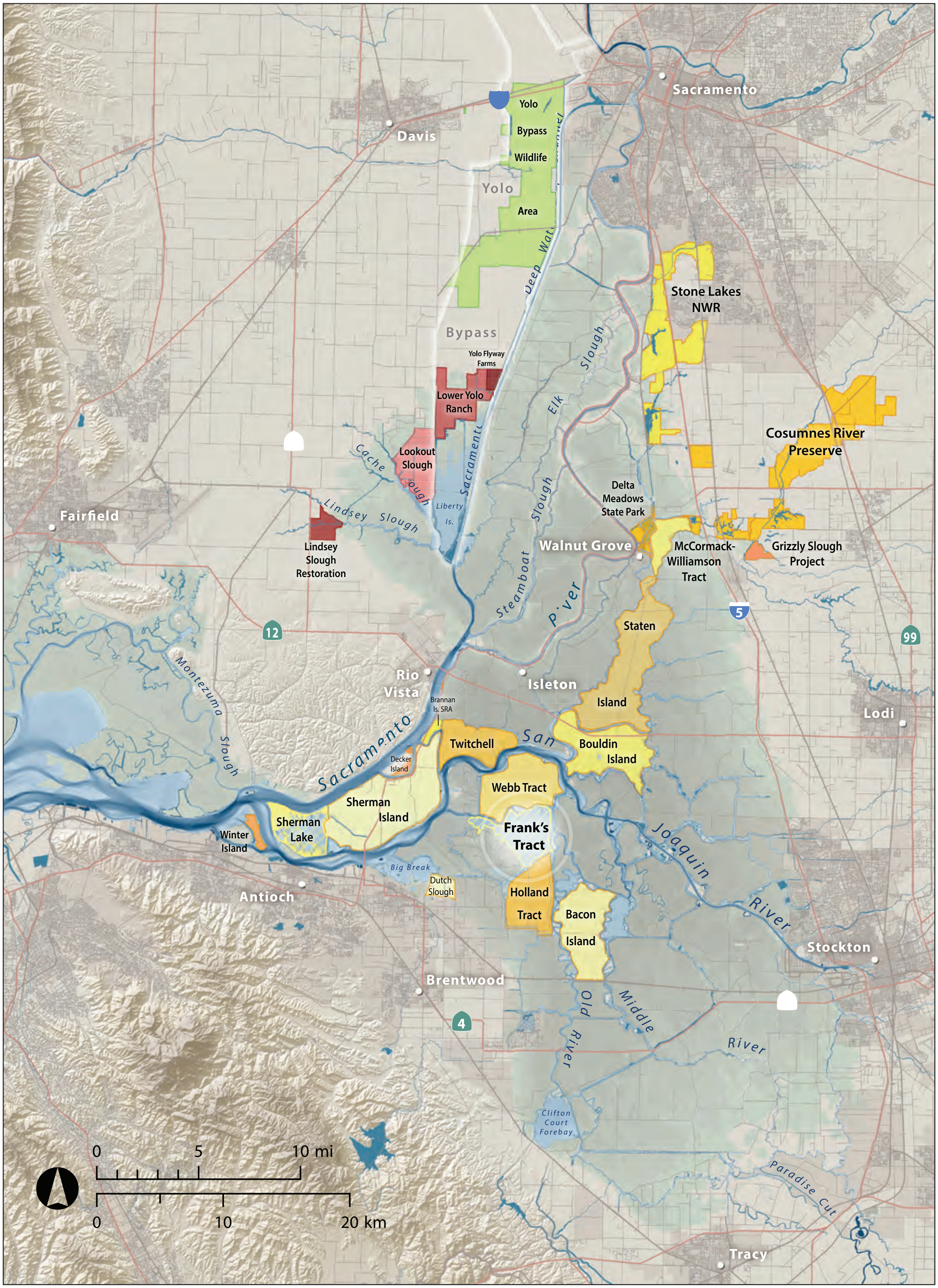
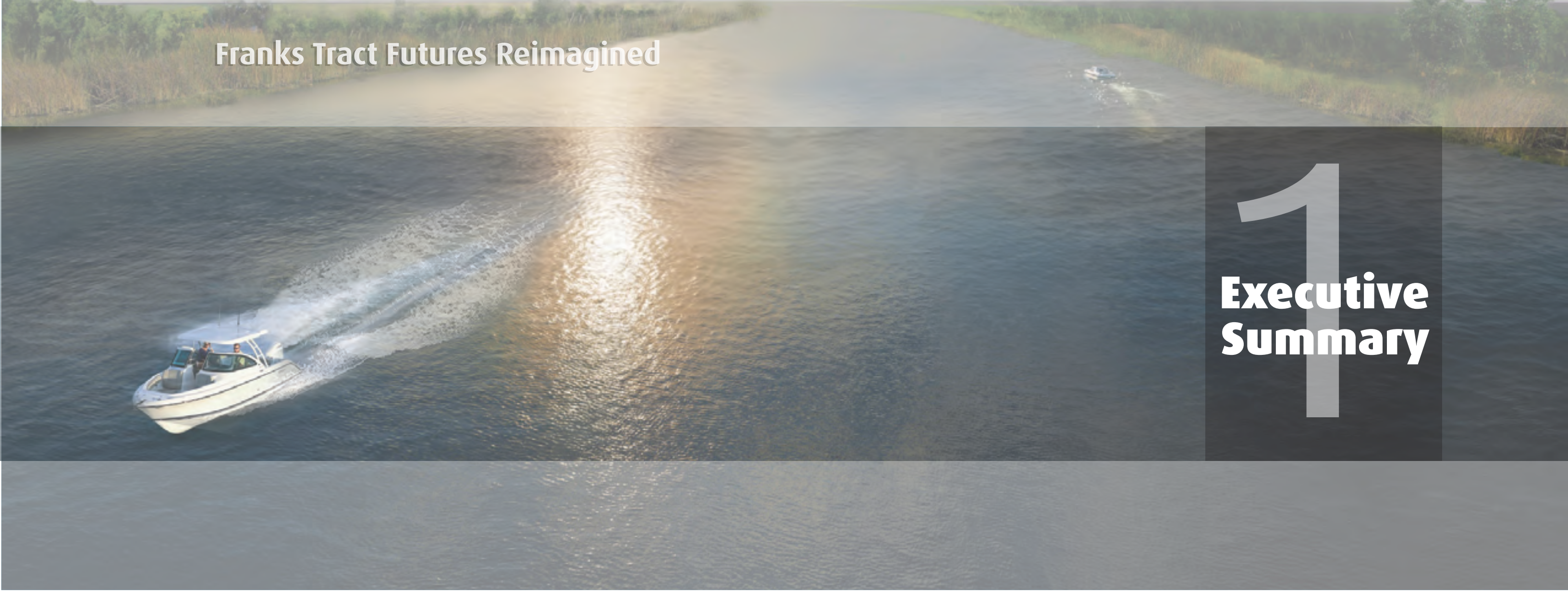
Delta Restoration Frontiers



Planned restoration and fish habitat: Cache Slough (red); Yolo Bypass Wildlife Area (green); Bypass (white boundary) and public lands corridor (various shades of yellow). Map: Amber Manfree



1 Executive Summary

A Bold Landscape Redesign in the Heart of the Delta

This summary of the 2020 Franks Tract Futures Reimagined report describes a proposal to redesign and enhance the 3,000-acre flooded island, and the smaller adjacent Little Franks Tract. The Tract is located about 40 miles south of Sacramento, California in the Sacramento-San Joaquin River Delta. The report covers a 2019-2020 planning process and community input into a proposal for improving conditions within the Tract first explored in 2017-2018.

Franks Tract, a shallow lake-like area, is a popular recreational and fishing destination in the Delta, with associated important benefits to the local economy on Bethel Island. However, it is also a hot spot for invasive plants, predatory fishes and saltwater intrusion from the ocean into waterways used to convey freshwater supplies to cities and agriculture throughout California.

As one of the least subsided and largest flooded islands in the central Delta, Franks Tract is a strong candidate for regional scale improvements to navigational channels, shoreline recreational amenities, and ecosystem function. Since 2017, the California Department of Fish and Wildlife, working with other state agencies and a multi-disciplinary consultant team, has undertaken a two-stage planning process to develop and evaluate a multi-benefit project for enhancing Franks Tract. After the second 2019-2020 phase, which involved four public-facing rounds of design and comment, a single design was selected as the preferred concept. The process and proposed changes embody emerging conservation guidance for the region described in the 2018 *A Delta Renewed, 2019 Delta Conservation Framework*, and the ongoing Public Lands Strategy.

Project Benefits

The preferred concept for Franks Tract would redesign the landscape, adding new land masses, tidal marshes, navigation channels, beaches and other amenities. The design addresses deteriorating environmental, safety, and water quality conditions in the area (see p.2). Among diverse benefits, it would: improve recreational boating and navigation (through dredging and reduction in aquatic weeds); create beaches, mooring sites, sheltered coves, day-use areas, and other amenities within the state recreation area; improve remnant levees that provide wave sheltering adjacent to Bethel Island and Little Franks Tract while maintaining open water views and marina access; create large areas of tidal marsh, riparian channel edge, and ecologically valuable features that provide habitat for a variety of species, including species of concern, sport fish and waterfowl; improve water quality for human use by reducing salinity in the central and south Delta; and help Franks Tract and local communities adapt to sea level rise (see map p.4).

Photo: Rick Lewis

Co-Design with the Public and Stakeholders

Meaningful public engagement in planning and design has been a guiding principal of the Franks Tract landscape redesign and enhancement project. Designing with, rather than designing for, those who have a stake in the outcome was and is a top priority. Incorporating local knowledge and stakeholder priorities also requires a strong grounding in place – the unique place that is Franks Tract in the central Delta.

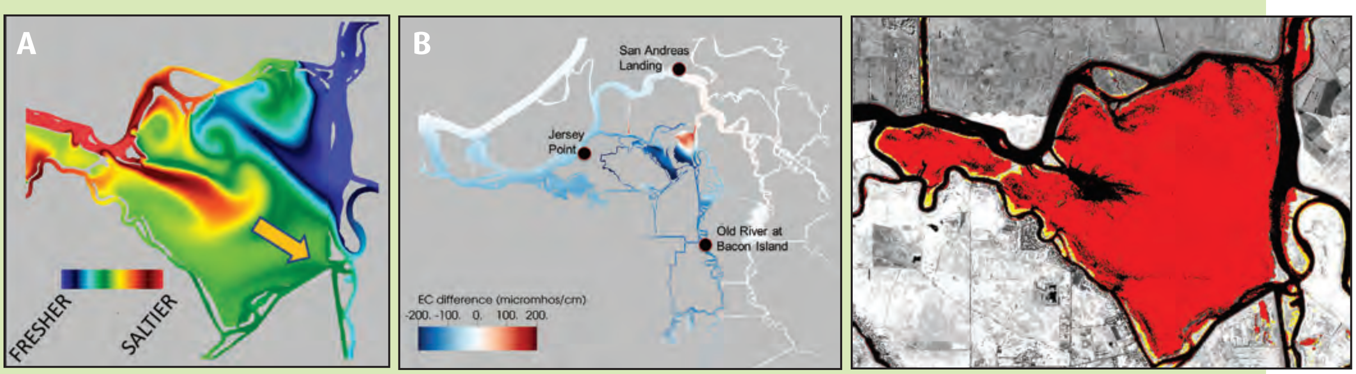
The goals of the Franks Tract project are to benefit native and desirable species by re-establishing natural ecological processes and habitats, provide enhanced recreational opportunities and other community benefits, and improve water quality. More detailed project objectives reflect input from prior Franks Tract restoration efforts, State Parks' General Plan for the Tract, and stakeholder input. Overall, the project seeks to find a balance of benefits across all objectives that will be sustainable over time.

The project team engaged with state and federal agencies, local districts, community members and other stakeholders throughout the planning process, and made the results transparent at every level. The project formed a Steering Committee, comprised of relevant state and local agency representatives, and an Advisory Committee, comprised of representatives of many diverse stakeholder interests. These committees served as the central bodies for deep engagement in the Franks Tract planning process. Public input was solicited early in the process, as well as during and after concept refinements via meetings held in the vicinity of Bethel Island, online Franks Tract user surveys, and other outreach (see timeline p.3). Public comments received on a draft version of this report resulted in revisions incorporated into the final report.

Deteriorating Conditions

While boaters, hunters, and anglers clearly value the open waters of Franks Tract, the ecological and water quality problems of this island are now impinging on the greater Delta and California water uses and compromising what the local economy values most: access to first- rate recreational and fishing waters. If no steps are taken to improve conditions on Franks Tract, current conditions could easily worsen. Dense mats of aquatic weeds will continue to degrade fish and wildlife habitat, spur algal blooms, and impede boat passage. Management with herbicides must be ongoing and remains burdensome. At the same time, healthy tidal marshes critical to native species will remain scarce in the Delta unless more are restored in the least subsided areas like Franks Tract.

Another contributor to deteriorating conditions is the direct connection provided between the lower San Joaquin River and Old River through Franks Tract. This allows saltier water and fish to be drawn into the south Delta into the zone of influence of the state and federal water projects. The presence of even small quantities of salt compromises the quality of fresh water needed for irrigation, drinking, and other uses throughout the state. As droughts recur more frequently or lengthen with climate change, and as the sea level rises, countering salt water intrusion from the ocean will require expensive and disruptive management measures such as the emergency drought barrier built on False River in 2015. The barrier consisted of 150 tons of rock, 750 feet across the top and 120 feet wide at the base. Installation and removal cost taxpayers approximately $37 million.



Current tidal conditions pump salt water into the Tract but don't let it out again (A). Modeling suggests a reduction in these conditions in a reconfigured landscape (B). Conditions under a project would be less favorable to submerged aquatic vegetation (fall 2019 extent shown in red) Sources: DWR & Khanna, CSTARS, UCD .

Co-Design Timeline 2019-2020

Over 14 months, the planning team worked through a public process on four rounds of concepts for redesigning Franks Tract. The first round consisted of 7 potential project designs plus the No Action (no project) alternative. Input from committees and the public narrowed the field down to 3 designs, and more recently to a preferred concept (see next page).

2019

07/11 Kick off Meeting (public)

Project background and planning process overview.
Introduction to ESA-led team and overall project approach.

08/29 The First AC/SC Workshop

Reviewed and received input on the project goals and objectives
Reviewed and received input on the No Action alternative scenario
Shared the initial results of the (online) Stakeholder Survey
Conducted a design charrette to receive input on the first round of design concepts

ROUND 1

Concept 1 - No Action
Concept 2 - Light touch - minimal project
Concept 3 - Open water berm and channel
Concept 4 - Northern archipelago

Concept 5 - Bays and channels
Concept 6 - Central land mass
Concept 7 - Eastern landmass and central island

11/06 The Second AC/SC Workshop

Reviewed and received input on the revised design concepts
Reviewed and received input on the draft evaluation methods and criteria
Shared the initial results of hydraulic modeling, received input on the initial recreational features design ideas and marsh aesthetic surveys
Conducted a design charrette to receive input on the next round of design concepts

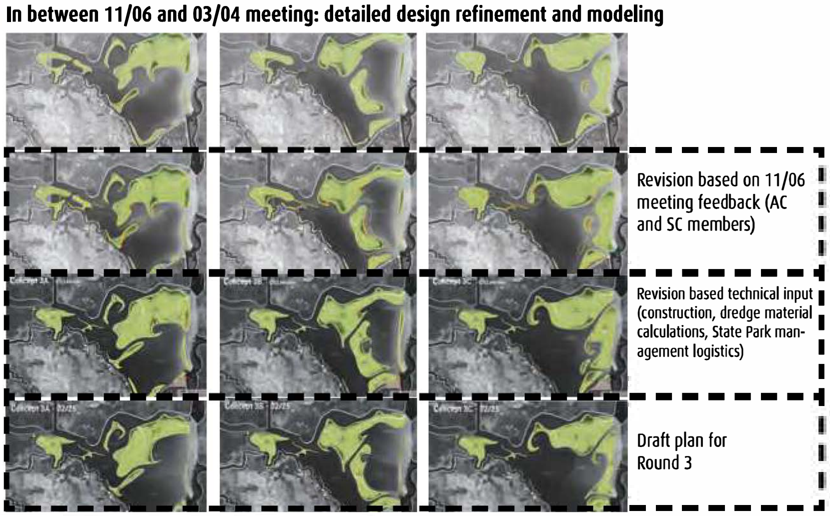
ROUND 2

Concept 2A - Open water berm and channel
Concept 2B - Central land mass
Concept 2C - Eastern landmass and central island

ROUND 3

In between 11/06 and 03/04 meeting: detailed design refinement and modeling

2020



03/04 The Third AC/SC Workshop

Reviewed and received input on the revised, 3rd round of design concepts
Reviewed the performance of the three concepts in meeting the project objectives
Conducted a design charrette to receive input on the next round of design concepts

ROUND 4

Concept 1 - No Action
Concept 3A - Open water berm and channel
Concept 3B - Central land mass
Concept 3C - Eastern landmass and central island

process is ongoing

Preferred Landscape Redesign Concept

The project design for Franks Tract and Little Franks Tract establishes a large area of intertidal marsh with channels, deepens open water areas to discourage nuisance submerged aquatic vegetation, and creates water and land based recreational opportunities. Re-establishing tidal marsh and associated channels would require raising selected areas 8-11 feet as Franks Tract is currently subsided below sea level. The design addresses all local, state and regional priorities (see pp.10-13 FTF2020) and meets all project goals and objectives (see Sections 4-5 FTF2020).

Navigation: Fast water navigation routes between key locations were identified as critical by boaters and recreational users. The project includes extensive deeper dredged areas in open water and navigable channels that would reduce growth of shallow water weeds identified as a nuisance to boating. The project includes other measures to improve boating safety, such as removing existing underwater snags and hazards, and sheltering the more wave-exposed eastern entrances to the Tract. Finding a way to allow for fast and safe boat navigation through Franks Tract while also meeting the water quality objectives was a key planning consideration. Channel widths were modeled to quantify the effects of channel size on

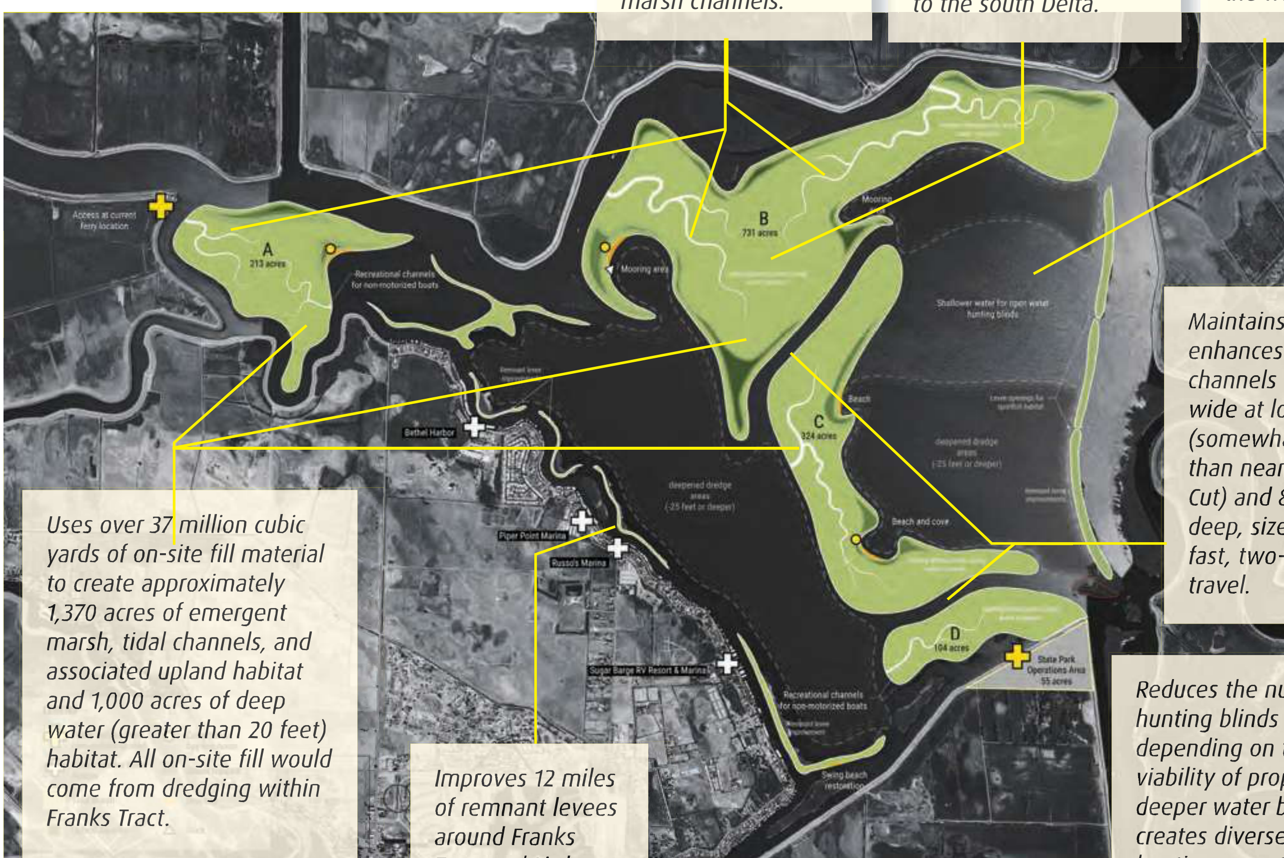
New Marsh, New Beaches, New Amenities, Less Weeds, Less Salt

The project proposed for Franks Tract develops three focal points for boat-to access to recreational activities that would attract three different user groups. The design pairs the eastern open water area with the active water sports enthusiasts; the Little Franks Tract with non-motorized boaters and paddlers; and the north end of the western open water area with a mooring for those with larger boats.

Creates approximately 21 miles of tidal marsh channels.

Builds a central tidal marsh landmass which maintains open water in front of Bethel Island, creates accessible, boat-in, land-based recreation, and impedes salt water movement from the western Delta to the south Delta.

Maintains about 1,900 acres of shallow water (less than 6-8 feet deep) on the Tract.



Maintains and enhances through-channels 400 feet wide at low water (somewhat wider than nearby Holland Cut) and 8-9 feet deep, sized to allow fast, two-way boat travel.

Uses over 37 million cubic yards of on-site fill material to create approximately 1,370 acres of emergent marsh, tidal channels, and associated upland habitat and 1,000 acres of deep water (greater than 20 feet) habitat. All on-site fill would come from dredging within Franks Tract.

Improves 12 miles of remnant levees around Franks Tract and Little Franks Tract to shelter flood protection levees and adjacent waterways from waves.

Reduces the number of hunting blinds by 29-36, depending on the viability of proposed deeper water blinds, but creates diverse new hunting opportunities in tidal marshes.

Does not significantly alter flood conveyance or high water levels in Franks Tract.

Creates 5 sheltered beach locations.

LEGEND

- Public Access Point (non-motorized only)
- Private Marina Water Access
- Tidal Marsh
- Upland Riparian
- Camp Sites/ Day-use Areas
- Beaches
- Dock

water quality impacts. The resulting channels are sized to allow fast, two-way boat travel.

Recreation: Recreational features focus on maintaining open water areas for boating and creating new types of recreational opportunities. Slow-water channels, especially in Little Franks Tract, would allow for non-motorized boating. Well-designed beaches would offer day use, sunbathing, swimming, as well as proximity to the water for water skiing and wakeboarding. Mooring coves would provide sheltered destinations for boaters. Opportunities to maintain or enhance sport fishing were integrated into the design of habitat enhancements (See Ecology).

Local Economy: The economic wellbeing of Bethel Island is reliant on the popularity of outdoor recreation in the central Delta. Jobs data show that approximately half the employment on Bethel Island is directly tied to recreation. A key planning consideration for the project was how best to balance the range of recreation interests while maintaining or benefiting the local economy. The current and ongoing degradation of environmental conditions in Franks Tract is a business risk. If the boating and fishing conditions are first-rate, and navigation and access are sustained or improved, the prospects for ongoing local business success are strongest. Overall, the key objectives of the Franks Tract project are in line with local business goals and economic development. The project seeks to reduce weeds, restore native ecology, and enhance recreation, all which could help grow local economic opportunity.

Ecology: Extensive new areas of tidal wetland would provide enhanced habitat and food production for fish and wildlife. Tidal marsh with narrow channels along the north of Franks Tract would provide refuge and a corridor for out-migrating juvenile Chinook salmon. The creation of tidal marsh in Little Franks Tract and the western part of Franks Tract would provide rearing and foraging habitat and food web support in the areas Delta smelt are most likely to occur. Modeling indicates that fisheries benefit from the project due to reduced risk of entrainment into Old River and the water supply pumps. The redesign project would maintain areas of sportfish habitat, as bass fishing is a key economic driver. The additional edge habitat along tidal marshes and remaining open water provided would be desirable for largemouth bass and striped bass respectively.

Water Quality: Based on hydrodynamic modeling conducted for the project, the overall configuration of tidal wetlands in all three final landscape redesign concepts would reduce salinity transport through Franks Tract, with meaningful improvements to water quality for drinking and irrigation supply, among many beneficial uses. More in-depth modeling indicates that the preferred concept improves water quality in the central Delta under a variety of flow conditions and reduces potential fish entrainment, which currently limits in-Delta diversions and the reliability of water operations. The project provides significant drought protection, reducing the frequency with which an emergency salinity control structure would be needed. Moreover, the relative efficacy of the project goes up as sea level rises.

Flood Protection: Remnant levees around Franks Tract shelter critical flood protection levees from overtopping and erosion from waves. The Bethel Island Municipal Improvement District and others are interested in project features that enhance the remnant levees in order to reduce required flood protection levee maintenance activities and associated costs. The preferred concept for the project would raise and widen levees with dredge or other material while retaining key gaps used by boaters. Flood modeling was conducted on the preferred concept using 2017 flood season data to simulate flood water levels throughout the Delta. Results indicate the preferred concept does not significantly alter flood conveyance or high water levels on the Tract.

Construction & Cost

Rearranging a vast shallow open water area into a new landscape is an ambitious construction task. The Franks Tract 2020 project conducted an assessment of construction options, reviewing feasibility and engineering constraints, types of onsite fill material, duration of construction, and unit rates for movement of material. The assessment concludes that the preferred design concept is feasible to construct (see chart). Local material dredged from Franks Tract is the least cost alternative and is available in sufficient quantities to construct the preferred concept. The project pricetag is estimated at $560 million, though costs could be lowered by reducing the area of constructed land mass in Franks Tract and Little Franks Tract. The duration of the construction period is estimated at four to nine years minimum.

Restoration Quantity	Preferred Concept
Marsh Area (acres)	1,370
Recreational Use (acres)	12
Fill to Grade (CY)	25,834,000
Consolidation (CY)	11,401,000
Total Fill/ Dredging (CY)	**37,235,000**

CY= cubic yards

Project Relation to Water Project Operations

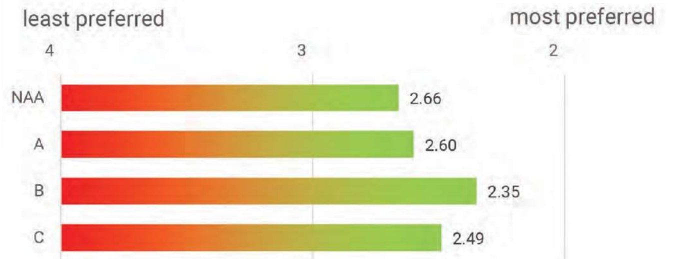
The Franks Tract project does not influence decisions about water project operations, water quality standards, direct improvement of existing flood protection levees, and local infrastructure planning. However, the Advisory Committee did ask the planning team to qualitatively consider how ongoing water project operations and any delta conveyance project may relate to the proposed Franks Tract reconfiguration. The planning team considered various seasonal and flow scenarios and concluded that changes in water project operations in response to the project are unlikely to significantly offset the project's water quality benefits in the central Delta for most seasons across a range of wet and dry hydrologies. Tunnels would not alter the Delta outflow required to meet regulatory requirements nor do they free the agencies from their obligations to do so. The scenario in which Franks Tract and any Delta conveyance project would most likely have to be considered together is the fall during dry or critically dry years (see p.55 FTF2020 & Appendix D for details).

Future Outlook

The landscape redesign and enhancement actions developed and selected through the 2019-2020 co-design process suggest a bold, sustainable change in the heart of the Delta. Stakeholders recognize that any feasible project must achieve multiple benefits to generate sufficient public and financial support for what would be a major construction effort. In addition, any project must ultimately be supported by the local community to move forward. As stakeholders and the public consider the future of Franks Tract, the following key findings offer a foundation for next steps.

- At the highest level for consideration, a redeveloped Franks Tract offers an opportunity for improvements in ecology, recreation, water quality, and other community benefits.
- Public surveys agree with the Advisory and Steering Committees that Concept B currently offers the best redesign vision for Franks Tract.
- There would be unavoidable trade-offs with any project, especially with respect to costs and construction impacts, but the cost of taking no action is high.
- Project benefits are expected to be resilient to future sea-level rise.

Overall Comparative Ranking of Design Concepts



Summer 2020 public survey rankings of 3 design concepts for Franks Tract and No Action alternative. Source: UCD

- For the local community, enhancing recreational opportunities is a must. A project without a robust recreational component and reliable sources of funding to maintain this component will lose community support.
- For State Parks, the proposed recreational components would require: development of new State Park operation and maintenance facilities in the vicinity of Franks Tract, a General Plan amendment or new management plan for the State Recreation Area, funding to support the operation and maintenance of the new recreation facilities and recreation use, and the establishment of new staff positions to support the new facilities and activities.
- Broad local, regional, state, and federal support is needed to move the project forward, including identifying sources of funding. Before any project would move forward, construction funding would need to be secured, along with a commitment to long-term operations and maintenance funding for recreational, habitat and water quality changes.
- Since cost remains a high-level feasibility issue, the next phase would explore project refinements to reduce overall costs.
- Other outstanding issues remain further work on how best to make boating through the dangerous corner at Holland Tip safer; further consultation with duck hunters and others in the design and management plans for the proposed marshlands and hunting blinds; further discussions with stakeholders on marsh aesthetics and the experience of boating through a channel between landmasses; further efforts to creatively separate conflicting activities (such as motorized and non-motorized boating) by distancing them in time and space; developing a clearer design for a State Parks facility in the vicinity of Franks Tract; and considering key remaining design issues for Little Franks Tract so that it can provide scarce habitat and food for native fish.

Acknowledgements in Brief
Advisory & Steering Committees

Primary Consultants: Environmental Science Associates; University of California Davis; Dangermond Group; Compass Resource Management; Moffat & Nichol; Economic and Planning Systems.

California Agencies: Fish & Wildlife, Water Resources, Parks & Rec

Report Production: Ariel Okamoto & Darren Campeau

Project Contact: Carl.Wilcox@wildlife.ca.gov

Franks Tract Futures Information: https://franks-tract-futures-ucdavis.hub.arcgis.com https://wildlife.ca.gov/Conservation/Watersheds/Franks-Tract

2 Introduction

This report describes a proposal to improve Franks Tract, a 3,000-acre flooded island, and the smaller adjacent Little Franks Tract, about 40 miles south of Sacramento, California. The report covers a 2019-2020 planning process and community input into a proposal for enhancement and renewal of the Tract first explored in 2017-2018.

Franks Tract, a shallow lake-like area, is a popular recreational and fishing destination in the heart of the Delta region, with associated important benefits to the local economy. However, it is also a hot spot for invasive plants, predatory fishes and saltwater intrusion from the ocean into waterways used to convey freshwater supplies to cities and agriculture throughout California.

As one of the least subsided and largest, flooded islands in the central Delta, Franks Tract is a strong candidate for regional scale improvements to navigational channels, shoreline recreational amenities, and ecosystem function. Since 2017, the California Department of Fish and Wildlife (CDFW), working with other state agencies and experts, has undertaken a two-stage planning process to develop and evaluate a multi-benefit project for enhancing Franks Tract. To conduct the planning process, CDFW hired a multidisciplinary consultant team led by Environmental Science Associates and supported by University of California Davis researchers, the Dangermond Group, Compass Resource Management, Moffat & Nichol, Economic and Planning Systems, and others. During the most recent 2019-2020 planning phase, the team worked with a steering committee and an advisory committee made up of local stakeholders and the public to co-design four iterations of conceptual designs, including evaluations of their respective benefits to navigation, recreation, local economies, ecological processes, tidal marsh habitat, flood protection, water quality, and water supply reliability, as well as construction costs, and construction impacts. Ultimately, a single design was selected as the preferred concept. This report outlines the processes used to engage stakeholders and the public, presents conceptual designs, and explores the benefits and tradeoffs of the preferred concept in achieving multiple benefits for the community and Delta region.

Site History

Franks Tract is located in the Sacramento –San Joaquin Delta (Delta) in California's Central Valley. The Delta is where fresh water from major rivers (the Sacramento River in the north and the San Joaquin River in the south) mixes with salt water from ocean tides (San Francisco Bay and the Pacific Ocean to the west). Historically, the Delta, including Franks Tract and Little Franks Tract, was an extensive network of tidal marsh and inter-tidal channels. Beginning in the late 1800s, levees were constructed to create islands for agricultural use. Over time, these levees degraded and breached. Levees around Franks Tract and Little Franks Tract repeatedly failed. After a breach in 1938, the Franks Tract levees were not repaired, leaving the island submerged. Decades later, in 1982, Little Franks Tract also flooded, leaving the large flooded island landscape seen today.

In terms of the historic Delta landscape, reclamation fundamentally altered the region's character by creating islands and eliminating, straightening and connecting dead-end channels. The increase in interconnectedness, along with subsequent flooding of subsided islands like Franks and Little Franks Tract, has doubled the area of open water habitat in the Delta, changed tidal circulation patterns, reduced water residence times, and increased flow velocities. These changes have also reduced food web production, shelter, and habitat complexity for aquatic species throughout the Delta (*Delta Transformed*, SFEI, 2014).

Navigation Map Franks Tract

Franks Tract today consists of two main water bodies — a large 3,000 acre submerged area and a 330-acre portion known as Little Franks Tract. The Tract is surrounded by a network of waterways and adjacent islands. On the north side lies False River and Webb Tract, on the east Old River and Mandeville Island, on the south Sand Slough and Holland Tract, and on the west Piper Slough and Bethel Island.

Current Conditions

Franks and Little Franks Tract are vast, flooded islands dominated by shallow open water with little tidal marsh. The majority of the open-water area is less than 10 feet deep (6 to 8 feet below mean lower low water) and filled with dense submerged aquatic vegetation. The substrate is relatively uniform, composed of silt, sand, and peat. Tules and submerged aquatic vegetation grow in the open water areas and along the shorelines of the Tract. Extensive reaches of Brazilian waterweed (*Egeria densa*), a non-native submerged plant species, can be found in Franks Tract and throughout the Delta. The infestation of Egeria and other submerged aquatic plants presents challenges for navigation, recreation, agriculture, and ecosystem processes. Nonetheless, the Tract supports a variety of native and non-native wildlife including fish, birds, mammals, and plants. Most of the fish currently in Franks Tract are non-native fish species, particularly largemouth bass, striped bass, and sunfishes. The prevalence of invasive plants and the associated predatory fish community (Grossman 2016) make the area poor habitat for native species such as Delta smelt.

Franks Tract encompasses the Franks Tract State Recreation Area, owned and managed by the California Department of Parks and Recreation (State Parks). Classification as a State Recreation Area indicates the area was selected and developed, and is now operated, to provide outdoor recreation opportunities (Public Resources Code Section 5019.56). Franks Tracts is a popular destination for boating and water sports, fishing, and waterfowl hunting but the area offers few land-based recreational opportunities for non-boaters. Fishing tournaments and other recreational events are often based in marinas along the Bethel Island waterfront. These facilities contribute to the local community and economy.

While boaters, hunters, and anglers clearly value the open waters of Franks Tract, the ecological and water quality problems of this island are now impinging on the greater Delta and California water uses. The biggest problem is the direct connection provided by Franks Tract between the lower San Joaquin River and Old River through False River. This allows salt water and fish to be drawn into the south Delta into the zone of influence of the state and federal water projects.

See Background Primer (p.14) for more detailed background on key environmental problems in the Tract.

Future Outlook

If no steps are taken to improve recreational and habitat conditions on Franks Tract, current conditions could easily worsen. While sportfishing and other current recreational activities may continue, navigational hazards and poor ecosystem quality will persist as aquatic vegetation grows and spreads. Dense mats of aquatic weeds will continue to degrade fish and wildlife habitat, spur algal blooms, and impede boat passage. Management with herbicides must be ongoing and remains costly.

Healthy tidal marshes critical to native species will remain scarce in the Delta unless more are restored in the least subsided areas like Franks Tract. As droughts recur or lengthen with climate change, and as the sea level rises, salt water from the ocean will intrude increasingly into Franks Tract and the Delta. Countering such water quality challenges will require additional expensive and disruptive management measures such as emergency drought barriers like the one built on False River in 2015 (see pp. 14 and 59).

Previous Franks Tract Initiatives

The project and process described in this report build on a prior feasibility study prepared by CDFW in 2017 and 2018. The study, entitled Franks Tract Futures?, explored options for achieving multiple ecosystem and water quality benefits at the central Delta site. The 52-page 2018 study described preliminary proposals for changes to the local landscape and waterways, early stakeholder feedback from State Parks and neighboring communities, and results from initial hydrodynamic modeling and engineering studies.

One primary outcome of the 2018 planning effort was a stronger understanding of local views and concerns. From a stakeholder and public perspective, the initial design concept presented in this early study was clearly not feasible in terms economic, recreational and aesthetic values. Planners found local communities were wary of significant change to the tract, as well as of any top-down decision making that did not take their interests and place values into account. Local communities expressed significant interest in being involved in any future design and planning processes for potential changes to Franks Tract. The 2018 effort concluded with recommendations for more intentional and open communication between state agencies and the general public (see Section 3).

The current 2019-2020 design process responds to the public concerns outlined above. The team used a transparent and participatory process to see if options proposed were feasible, not just from an engineering and ecological perspective, but also in terms of community support. Throughout this document, the prior effort will be referred to as Franks Tract Futures 2018 and the current effort as Franks Tract Futures Reimagined 2020.

Photo: Brett Milligan

Context for CDFW Involvement

As California's trustee agency for the fish and wildlife, CDFW has long advocated for ecosystem restoration in the Delta. As part of the California Natural Resources Agency 2016 Delta Smelt Resiliency Strategy (see p. 10), CDFW took the lead in assessing the feasibility of restoring some of Franks Tract's historical ecological and hydrodynamic functions based on the guidance of A Delta Renewed *(2016). In the past, state and federal agencies had investigated a variety of alternatives for improving conditions at the Tract. Most prior proposals focused on water quality and supply. The current proposal focuses on achieving multiple benefits and ecological reconciliation.*

At the same time the initial Franks Tract Futures project feasibility study was being developed, CDFW was also working collaboratively within Delta communities to develop the 2018-2050 Delta Conservation Framework. *The Framework emphasizes early and active engagement with communities affected by conservation projects in order to co-create strategies to conserve natural resources. The Framework also emphasizes the importance of recognizing the Delta as place as required by the Delta Reform Act.*

At CDFW's direction, the current Franks Tract proposal addresses these other priorities, and reflects multi-objective, multi-interest decision-making by a variety of environmental, water quality, recreation, and local stakeholders. Beyond ecosystem restoration, the current planning process recognizes that any feasible project must generate sufficient public and financial support for what would be a major construction effort. The process also recognizes that any project must ultimately be supported by the local community to move forward. CDFW funded the most recent 2019-2020 Franks Tract planning process with Proposition 84 bond funds for Delta restoration.

PLANNING PRIORITIES

The restoration and renewal of Franks Tract will not be feasible without careful consideration of the interests of its owners, neighbors, and local communities, as well as state interests in providing recreational opportunities, preserving navigational routes, recovering native species, and protecting water quality and supply for all Californians. All participants in the planning process were invited to co-create and co-design the project products, and to weave their local expertise and priorities into the knowledge base of the project.

Local Priorities

Any proposed changes to Franks Tract and Little Franks Tract will affect those who live, work and play in the area. In an effort to learn more about how the area is currently used, CDFW reached out to many of these people, using a landscape research team from UC Davis. Outreach from prior and current efforts yielded the following common areas of concern and interest:

- Navigability and access to fast water navigable channels.
- Real estate values based on access to fast water, recreation opportunities, and open water views.
- Protection of the existing local economy including marinas and service industry (restaurants, gas stations, repair shops, storage, etc.). Any proposed project should contribute to, rather than compete with, the local economy.
- Creation of, and improvements to, recreation features (beaches, mooring and day use areas, wildlife viewing, etc.).
- Secured and sustained funding for ongoing maintenance and operation of recreational facilities.
- Reduction in nuisance species like aquatic weeds.

State and Federal Priorities

The priorities and interests of both state and federal agencies are also relevant to any proposals to improve or change Franks Tract. The Tract includes a state recreation area. And early on, California recognized the potential at Franks Tract to contribute to state goals for ecosystem health and native species recovery, as well as to facilitate improved recreation and water quality in the region.

Delta Smelt Resilience

The habitat improvements proposed for Franks Tract and presented in this report would further the goals, objectives and actions recommended in the State of California's 2016 Delta Smelt Resiliency Strategy. Delta smelt is an endangered native fish species uniquely adapted to life in the estuarine mixing zone, which occurs near Franks Tract (see 2018 report). The Strategy is a science-based document prepared by the state to address both immediate and near-term needs of Delta smelt, and to promote their resiliency to drought conditions as well as future habitat variations. The Strategy relies on conceptual models developed through intensive, interagency, science modeling and research conducted in 2015 and compiled in the Interagency Ecological Program Delta Smelt Management, Analysis, and Synthesis Team (MAST) Synthesis Report. This research helped articulate a suite of actions to be implemented by state agencies in the near future to benefit Delta smelt. A team of state and federal agencies, water contractors and NGOs also developed a framework that will be used to assess the outcomes of these actions individually and synergistically over time.

The Strategy's primary objective is positive population growth (>1) for Delta smelt. Goals related to achieving this objective include population growth, improvements to habitat conditions such as increasing small dendritic channels in restored marsh and shallow turbid areas, food resources, and turbidity, as well as reducing levels of invasive species (e.g. aquatic weeds and predators) and harmful algal blooms.

Parks & Recreation

Franks Tract encompasses a State Recreational Area (SRA). These areas are selected, developed, and operated by State Parks to provide outdoor recreational opportunities. The declaration of purpose developed for the Franks Tract SRA and approved by the State Park and Recreation Commission in 1966 is to permanently provide water-related recreational activities so that the recreational, scenic, historic, and scientific values of the area may be enjoyed by the public. The most current management plan for the area dates back to 1988. Given the potential magnitude of the changes to the Franks Tract SRA, as a result of the enhancement and renewal actions proposed in the Franks Tract 2020 study, it is likely that either an amendment to the existing General Plan, or a new management plan, is needed.

The 1988 General Plan for the Franks Tract SRA describes resource management policies; proposed uses, facilities and interpretive programs; and physical, biological, ecological, cultural, esthetic and recreational resources. In terms of its recreational value, the plan recognizes Frank Tract is an open waterway with no land-based facilities. The plan identifies fishing, waterfowl hunting, and navigation through the Delta as key existing recreational uses.

Overall State Parks supports the concept of restoring portions of Franks Tract SRA in order to benefit native fish species and to minimize habitat for non-native fish and plant species. State Parks does, however, have related concerns about ongoing maintenance and management costs resulting from the proposed creation of additional recreational features.

Water Quality and Supply

The Delta is a primary source of the state's freshwater supply for human consumption and agricultural uses. The two main water diversion programs, in addition to in-Delta uses, are the State Water Project and the Central Valley Project. The State Water Project, administered by the California Department of Water Resources (DWR), captures, stores, and conveys water from the Sacramento and San Joaquin Rivers to several water agencies throughout the state. Similarly, the Central Valley Project is a federal facility administered by the United States Bureau of Reclamation that stores and transports water for irrigation and municipal purposes used in the Central Valley and elsewhere.

Water derived in the Delta is used for a variety of purposes, including irrigation, domestic consumption, industrial use (i.e., power plant cooling), and environmental protection (i.e., habitat maintenance and water quality improvement). Water use and the volume of water available for use are in part controlled by water quality standards established in the Bay-Delta Water Quality Control Plan and enforced by State Water Resource Control Board to protect beneficial uses.

The planning team proposing a landscape redesign and enhancement of Franks Tract evaluated benefits and impacts under existing water operations and potential future operations of interest or concern to stakeholders. While DWR is coordinating with the project and provided hydrodynamic modeling of enhancement scenarios, the project is being developed independently from ongoing water operations, Delta exports, or proposals for alternate conveyance (see p. 23 Scope and p. 58).

Hunters enjoy blinds in Franks Tract. Photo: Alejo Kraus-Polk

Emerging Conservation Guidance

The landscape redesign and enhancement actions described in the following pages suggest a bold, sustainable change in the heart of the Delta that is in keeping with current and emerging state priorities. The proposed design offers a model of the kind of larger scale approach based on natural physical processes recommended in three important conservation visions for the region and the upper part of the San Francisco Estuary: the 2016 *A Delta Renewed*, the 2018 *Delta Conservation Framework*, and *the Delta Public Lands Strategy*.

A Delta Renewed is the last of a series of three sequential reports developed by the San Francisco Estuary Institute with support from CDFW. The reports provide the technical and scientific basis for a suggested approach to restoring the Delta. Based on input from twelve academic and government science advisors, the reports outline the Delta's past and present conditions, and suggest restoration approaches focused on harnessing the remaining natural physical processes in this much-altered and re-engineered system for the future. The Franks Tract restoration approach applies the recommendations in *A Delta Renewed* for flooded islands and former marsh (see Franks Tract Futures 2018 pp. 22-23).

The *Delta Conservation Framework* was developed between 2016 and 2018 by CDFW in partnership with Delta stakeholders. These stakeholders included federal, state, and local government representatives, conservation practitioners, non-profit organizations, landowners, residents, and business owners. Three primary sets of resources guided development of the Framework: feedback from a series of public workshops held in 2016; prior plans focused on the people and ecosystems of the Delta; and best available science on ecosystem processes in the Delta. From this foundation emerged seven conservation goals, 26 strategies to reach those goals, 200 pages of details, seven appendices, and a 30-year vision for a healthier Delta for both humans and wildlife: the *Delta Conservation Framework*.

The Franks Tract Futures Reimagined 2020 vision and planning process reflects at least three Delta Conservation Framework goals prioritizing stakeholder communication, socioeconomic considerations, multi-benefit solutions, and improvement of ecological processes to benefit society, natural communities, and species recovery.

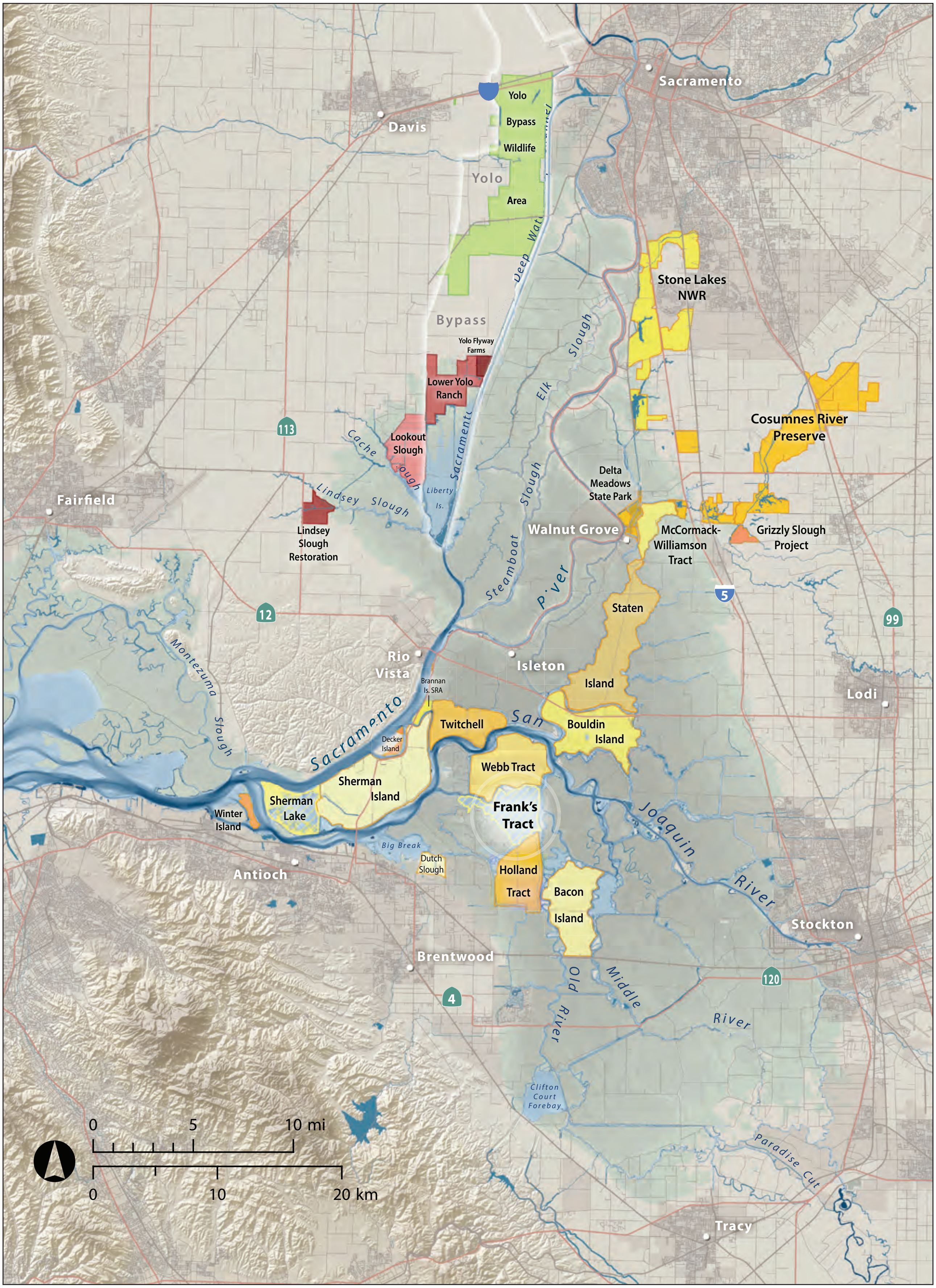
The changes proposed for Franks Tract also complement the larger conservation vision of the Delta

Healthy tidal marsh at Lindsey Slough near Cache Slough, one target area in the Delta for habitat restoration. Photo: Amber Manfree

Public Lands Strategy (formerly the Central Delta Corridor Partnership). The Strategy recognizes the need to succeed in habitat restoration on public lands first, before approaching private landowners. It focuses on engaging the owners of public, and publicly-financed lands, interconnected throughout the central Delta from north to south, in forming a conservation lands corridor. With water and landscapes connected in this corridor, more benefits for fish and wildlife can be achieved. In the north and northeast areas, the corridor is characterized by lakes, floodplains, and tidal wetlands within the Stone Lakes National Wildlife Refuge, Cosumnes River Preserve, and the Cosumnes-Mokelumne river confluence. Southward, the corridor encompasses deeply subsided islands (Staten, McCormack-Williamson Tract, Bouldin, Webb, Holland, Bacon, Twitchell, Sherman, and Decker) and the flooded Franks Tract State Recreation Area (see map p.13).

Through the public lands strategy, public landowners hope to control invasive species, improve habitat for endangered Delta smelt and salmon populations, and support recreational boating, fishing, wildlife viewing, and waterfowl hunting, among other priorities — all elements of the current vision for improving Franks Tract.

Restoration Frontiers in Delta



Planned restoration and fish habitat: Cache Slough (red); Yolo Bypass Wildlife Area (green); Bypass (white boundary) and public lands corridor (various shades of yellow). Map: Amber Manfree

Background Primer on Marshes, Weeds, Barriers

Water primrose.

Re-establishing Tidal Marsh

Over the last several decades, numerous tidal wetland restoration actions have been planned and implemented throughout San Francisco Bay and the Delta. Most of the restoration sites are highly altered from their historic natural states and have ground elevations below sea level, like Franks Tract. The basic restoration approach, and the one proposed for Franks Tract, is to place fill to raise ground elevations to intertidal elevations at which emergent marsh vegetation can establish and persist. Beyond this, there are many additional considerations for re-establishing a diversity of aquatic habitats and natural processes to the site. For example, achieving habitat heterogeneity and complexity will require the re-establishment of blind channels that help drain the tidal marsh and provide food web nutrients that can flush into larger channels to support native fish species such as Delta smelt (see also A Delta Renewed, SFEI 2016).

It is critical to achieve vegetated tidal marsh and channel forms before new marsh sediment accretion is no longer able to keep pace with rising sea levels naturally (Baylands Goals Climate Change Update 2015). Marshes maintain themselves in relation to sea level by trapping inorganic matter in the form of sediment and accumulating organic matter in the form of plant roots and other plant material. Vertical accumulation via the buildup of organic matter (such as eventually forms peat) is particularly important for marsh sustainability in the central Delta. The Franks Tract landscape redesign project would use dredge material to provide intertidal elevations necessary for marsh plant growth. This is designed to allow vegetation establishment and provide for long term resilience to rising sea levels.

Discouraging Invasive Aquatic Weeds

Invasive aquatic plants have far-reaching impacts on the Delta ecosystem and are now widespread. The total invaded area in the Delta (submerged and floating aquatic vegetation, or SAV and FAV) increased from 5,000 acres in 2008 to 16,000 acres in 2014 and almost 17,400 acres in 2015 (Khanna et al. 2016). Invasive aquatic plants have changed shoreline habitat in the Delta by slowing water velocities and increasing water clarity, conditions which further their spread (Hestir et al. 2016). This dense mat of vegetation can also offer largemouth bass places to hide and hunt. Meanwhile, native species like Delta smelt, who like to stay in open water, are more vulnerable to attack in clearer waters. Such effects can propagate up and down the food chain, affecting the entire ecosystem. Invasive aquatic plants also impede boat travel and often require mechanical removal or chemical spraying to control. Prolonged drought has likely increased shallow habitat with slow moving water ideal for aquatic weeds.

*Submerged aquatic weeds in the central Delta increased each year from 2014-2017 (Ustin et al. 2017, Khanna: personal communication). More specifically, Franks and Little Franks Tracts are heavily vegetated by aquatic weeds including Richardson's pondweed (*Potamogeton richardsonii*), Brazilian waterweed (*Egeria densa*), and water primrose (*Ludwigia spp.*). Recent drought conditions may have promoted this growth. When the emergency barrier was installed and removed in 2015, changes in the movement of water within the Tract also changed the orientation and location of weed patches, worsening them in some areas and clearing them up in others. The state has been spraying Franks Tract with the aquatic herbicide Fluridone since 2006, targeting Egeria. Over the last five years, measures of native plant species diversity indicate some promising results of continued herbicide management. At present, however, aquatic weeds remain a key reason that Franks Tract supports more non-native than native fish species. The Franks Tract project would change the island's topography, deepening some areas and raising others so that conditions are not so conducive to submerged and floating aquatic vegetation.*

Protecting Water Quality During Drought

During drought and dry summer months, salt water from ocean tides intrudes into the western Delta — closer to irrigation and drinking water intakes— because there isn't as much freshwater flowing downstream from rivers, runoff and reservoir releases to push it back out. There are few options for keeping the tides out when major reservoir levels are drawn down, snowpack is low, and so many Delta channels are connected to others except to build multiple temporary barriers across key channels. The state first built such barriers in the Delta during the mid-1970s — two in 1976 and six in 1977. In 2015, following up on modeling suggesting that a single obstruction might be less disruptive to fish habitat while still protecting water supplies, the state built the most recent barrier across the False River.

The barrier was huge - 750 feet across the top and 120 feet wide at the base, and consisted of 150 tons of rock. Installation and removal cost taxpayers approximately $37 million (see photo p.59).

While engineers estimate the 2015 barrier served its purpose of protecting water supply, it was hugely disruptive to the local community in the vicinity of Franks Tract. The barrier significantly rerouted boat traffic, created unsafe high velocities in certain channels, threatened ferry operations to Bradford Island, and created slow water in Franks Tract that has been blamed for the spread of nuisance aquatic weeds. Temporary rock barriers also impede natural physical and biological processes still at work in the Delta ecosystem and fail to provide long term, permanent solutions to salinity intrusion problems. The Franks Tract project would change the way water moves and mixes through Franks Tract, offering a more sustainable approach to water quality management.

3 Engaging Stakeholders & the Public in Design

Meaningful public engagement in planning and design has been a guiding principal of the Franks Tract landscape redesign and enhancement project. Designing with, rather than designing for, those who have a stake in the outcome was and is a top priority.

Incorporating local knowledge and stakeholder priorities requires a strong grounding in place – the unique place that is Franks Tract in the central Delta. Regional interests charged with Delta planning and stewardship have made consideration of the Delta as a special place a policy priority. Core components of that regional vision include protecting the Delta's lands and communities, economy and way of life (Delta Protection Commission 2019).

The Delta is characterized by high rates of change, wherein even without the landscape transformations considered by the project – the "No Action alternative" – the Delta will continue to change. In this evolving place there will be more aquatic weeds, increasing rates of sea level rise, and further problems with salinity intrusion, changing conditions even if residents, scientists, water exporters and state agencies don't want them to (Milligan & Polk 2017).

So the real question is how to go about design and planning for these socio-ecological changes in an equitable and inclusive manner. Without engaging local place values no planning process can be successful or representative (Milligan & Polk 2017).

The Franks Tract project's engagement goals aimed to create and facilitate opportunities for stakeholders and members of the public to be integrally involved in the project planning and design process, from beginning to end. All participants co-created and co-designed the knowledge and products that emerged over the year-long project timeline. Co-design generally refers to inclusive and creative design processes that attempt to include all who might be positively, negatively, or neutrally affected by a design intervention or change in place. In this 2019-2020 project, co-design meant that diverse groups and experts, including designers, engineers, scientists, public agency representatives, boaters, fishers, hunters and local residents and business owners (all experts of the landscape in their own distinct way) worked together to contribute ideas and values driving the design concepts. It also entailed the iterative refinement of design concepts through inclusive rounds of review by these same participants (see Section 5).

Lessons Learned

Engagement efforts for the 2019-2020 project were based on the outcomes and recommendations of the prior 2018 Franks Tract Futures feasibility study. The latter clearly identified that although the first conceptual designs met state goals for water quality and ecological restoration, they fell far short of being accepted by the local and regional communities who would be the most impacted by the project. Based on those findings, the study stated that: "more detailed restoration planning will take into account the social, economic, and recreational interests of the affected local communities and user groups, in keeping with the collaborative principles outlined in the multi-agency Delta Conservation Framework". Based on outreach efforts, the study found that stakeholders and the public wanted to be involved in any further planning efforts, from the very beginning, and that that process should be fully transparent.

As next steps, the 2018 study proposed:

"...developing a variety of scenarios considering both the CDFW restoration design, as well as community and user group alternatives" as well as, "convening of a facilitated advisory group of local community interests (boating, fishing, economic, landowners, and hunting), local government, and other interested stakeholders..."

Accordingly, the follow-up 2019-2020 planning effort primarily focused on determining if the project could be redesigned to benefit both local and regional communities (such as through the creation of desirable recreational features), as well as to minimize detrimental impacts of the project to these same communities, while still meeting ecological and water quality goals.

Project Engagement and Co-Design Methods

Franks Tract 2020 used multiple modes of engagement to facilitate feedback and co-design activities with diverse stakeholders and the general public. In addition to in-person participation through committees and public meetings, modes of engagement included project website hosting, social media communications, creation of public online map-based surveys, fieldwork, canvassing and interviews. Each of these methods is briefly described below, with many of the products and results of each method are fully documented in Appendix A.

Project Startup, July 2019

Prior to the first project meeting and public workshop, UC Davis team members conducted outreach to support the project through background research, one-on-one meetings and on-the-ground fieldwork in the project region. This work served to solidify new committees (see below), to ensure that stakeholders and residents were aware of the upcoming planning process, and to confer with them on how the process should best unfold to ensure participation (timing of meetings, tour, etc.). This work built off contacts and relationships fostered in the earlier Franks Tract Futures 2018 feasibility study. Additional activities included regional canvassing and social media communication, creation of the project website, and collection of tidal marsh imagery to use in aesthetic preference surveys.

Formation of Project Advisory and Steering Committees, Spring-Summer 2019

The 2019-2020 planning process included formation of two important committees. The Advisory Committee (AC) was made up of representatives from all known key interests in the Franks Tract area, including local residents and landowners, marina and small business owners, local government representatives and reclamation districts, local hunters, fishers, boaters and recreational advocates. The AC served as the central forum for deep engagement and evaluation of Franks Tract Futures design concepts. Members had the opportunity to directly participate in, and influence the outcomes of, the design process. Throughout the yearlong process, members not only attended AC meetings, but also reviewed and commented on design materials and served as liaison to the larger stakeholder community (see Sections 4-5).

The Steering Committee (SC) was comprised of senior representatives from state, regional and local agencies responsible for decisionmaking, funding and implementation of the planning project, including California Departments of Fish and Wildlife, Water Resources, and Parks and Recreation, as well as the Delta Protection Commission and Delta Stewardship Council. Their primary responsibilities were to provide overall guidance for the project, attend project AC meetings for technical support, and to secure and share information within their respective agencies regarding the project.

Steering Committee

Name	Affiliation
Bill Harrell	California Department of Water Resources (DWR)
Erik Loboschefsky	DWR
Ted Sommer	DWR
Eli Ateljevich	DWR
Jacob McQuirk	DWR
Edward Hard	Division of Boating and Waterways (DBW)
Gina Benigno	California Department of Parks and Recreation (State Parks)
Steve Musillami	State Parks
Jim Micheaels	State Parks
Jennifer Cabrera	State Parks
David Moffat	State Parks
Erik Vink	Delta Protection Commission (DPC)
Karen Kayfetz	Delta Stewardship Council (DSC)
Jeff Henderson	DSC
Louise Conrad	DSC
Mike Roberts	California Natural Resources Agency (CNRA)
Jim Starr	California Department of Fish and Wildlife (CDFW)
Maureen Martin	Contra Costa Water District (CCWD)
Deanna Sereno	CCWD
Brian Holt	East Bay Regional Park District (EBRPD)
Mike Moran	EBRPD

Advisory Committee

Name	Affiliation
Regina Espinosa	Bethel Island Municipal Improvement District (BIMID)
Ryan Hernandez	Contra Costa County Water Agency
Russ Ryan	Metropolitan Water District (MWD)
Brian Sak	San Francisco Public Utilities Commission (SFPUC)
Karen Mann	Save the California Delta Alliance (STCDA)
Jan McCleery	STCDA
David Gloski	Bethel Island resident
Jamie Bolt	Bethel Harbor
Lenora Clark	STCDA, former commissioner DBW
Chuck Russo	Russo's marina
David Riggs	Sugarbarge RV resort and marina
Kathleen Stein	Bethel Island realtor
Blake Johnson	Engineer RD 2059
Robert Davies	President RD 2059
Bill Jennings	California Sportfishing Protection Alliance
John Francisco	Franks Tract hunter
Andy Rowland	San Joaquin Yacht Club
Mark Whitlock	BIMID, BI Chamber of Commerce, Delta Chamber of Commerce
Joshua Ireland	Bethel Island Resident and Pro Fishermen
Karen + Smith Cunningham	Five Palms Cattle
Paul Seger	Sierra Club, Diablo Water Agency
Katherine Jones Smith	San Joaquin Yacht Club
Jim Cox	California Striped Bass Association Western Delta Chapter
Tyson Zimmerman	Assistant GM. Ironhouse Sanitary District, RD 830 Trustee

Public and Advisory Committee Meetings, 2019-2020

The backbone of the engagement process consisted of both public and AC meetings. Outreach for the July 2019 kickoff meeting included canvassing on Bethel Island and the Franks Tract region, as well as online and media outreach efforts using social media, list serves, and print and online media outlets (the team later repeated these efforts to promote surveys). All public meetings were held in the immediate vicinity of Franks Tract and Bethel Island, with the farthest being at the Big Break Visitors Center in Oakley, although Covid-19 forced later meetings online.

July 2019 public meeting

The planning team held the two larger public meetings (up to 160 people) at key points within the project timeline to provide project information to the public and to receive their feedback (see also Sections 4-5). The team held an additional three AC meetings (all with SC members in attendance) throughout the project. These smaller, more focused meetings enabled the team to engage with advisors and stakeholders on project status and review detailed design, modeling, and evaluation criteria. Within these meetings, the primary objective of was to conduct “hands-on” design workshops to review, refine and advance the design concepts and their evaluation methods. The team provided all SC and AC members with meeting materials and surveys prior to in-person meetings, including those who could not attend the meetings. The team also compiled and shared meeting notes with all members by email and with the general public via the project website.

Fieldwork & Canvassing, 2019-2020

As part of its project fieldwork, the planning team visited precedent landscapes in the Delta, such as existing recreational areas like Sherman Island and Brannan Island, and took guided tours with the public agencies who manage these areas. The team also performed fieldwork to validate and assess conditions on-the-ground within the project boundaries, such as the condition of levees, boating routes, and boating hazards, among other factors. The team also conducted many interviews with stakeholders and residents in the field.

Website and Social Media 2018-2020

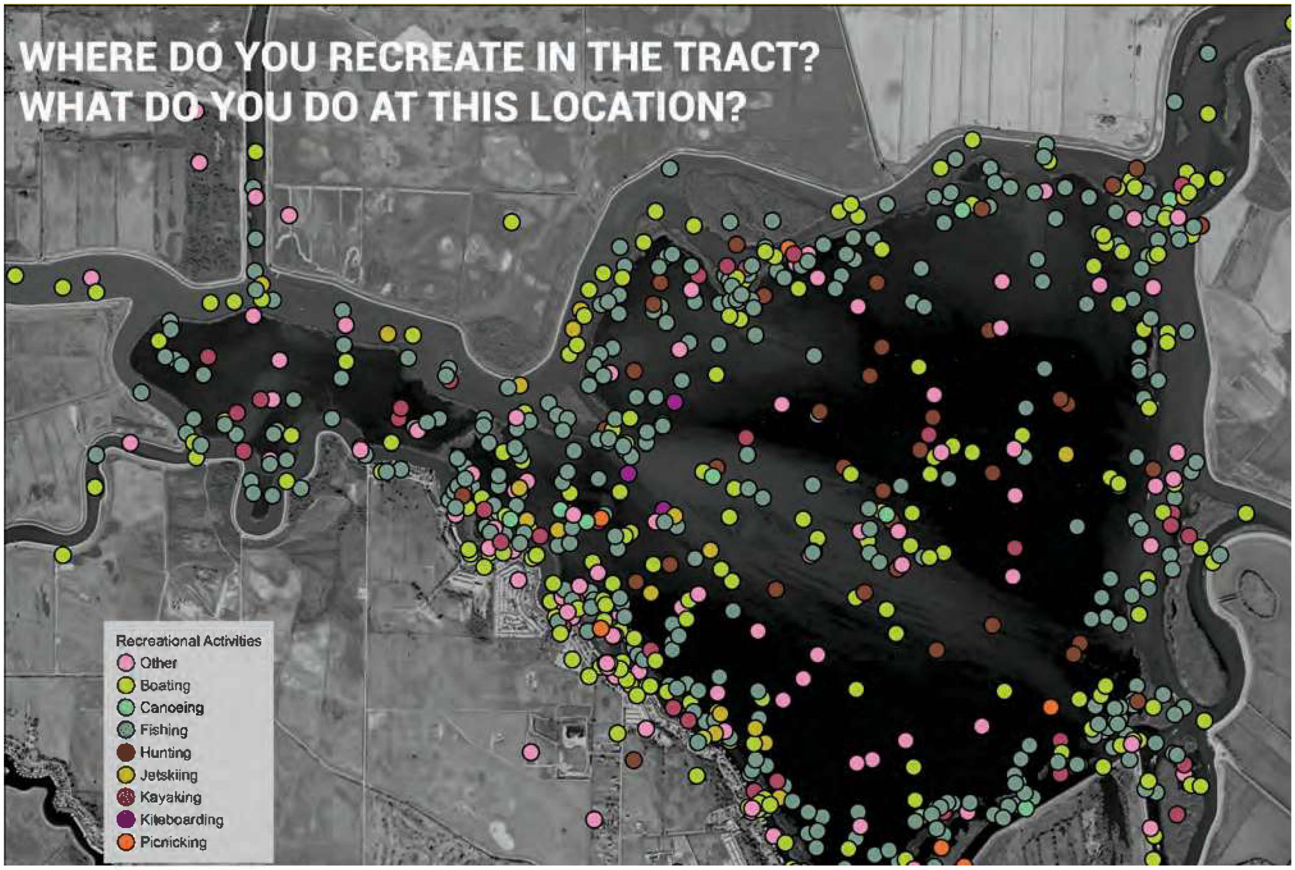
The planning team created the Franks Tract Futures website in 2018 (https://franks-tract-futures-ucdavis.hub.arcgis.com/) as a central hub for broad public involvement and planning information. Since then, the team has maintained and updated the site as new information has become available (posting meeting notes, sharing presentations, and making announcements, etc.). The team also created social media accounts (Twitter, Facebook, Instagram) to expand engagement, disseminate information, and provide additional forums for project-related discussion and communication with the community and stakeholders.

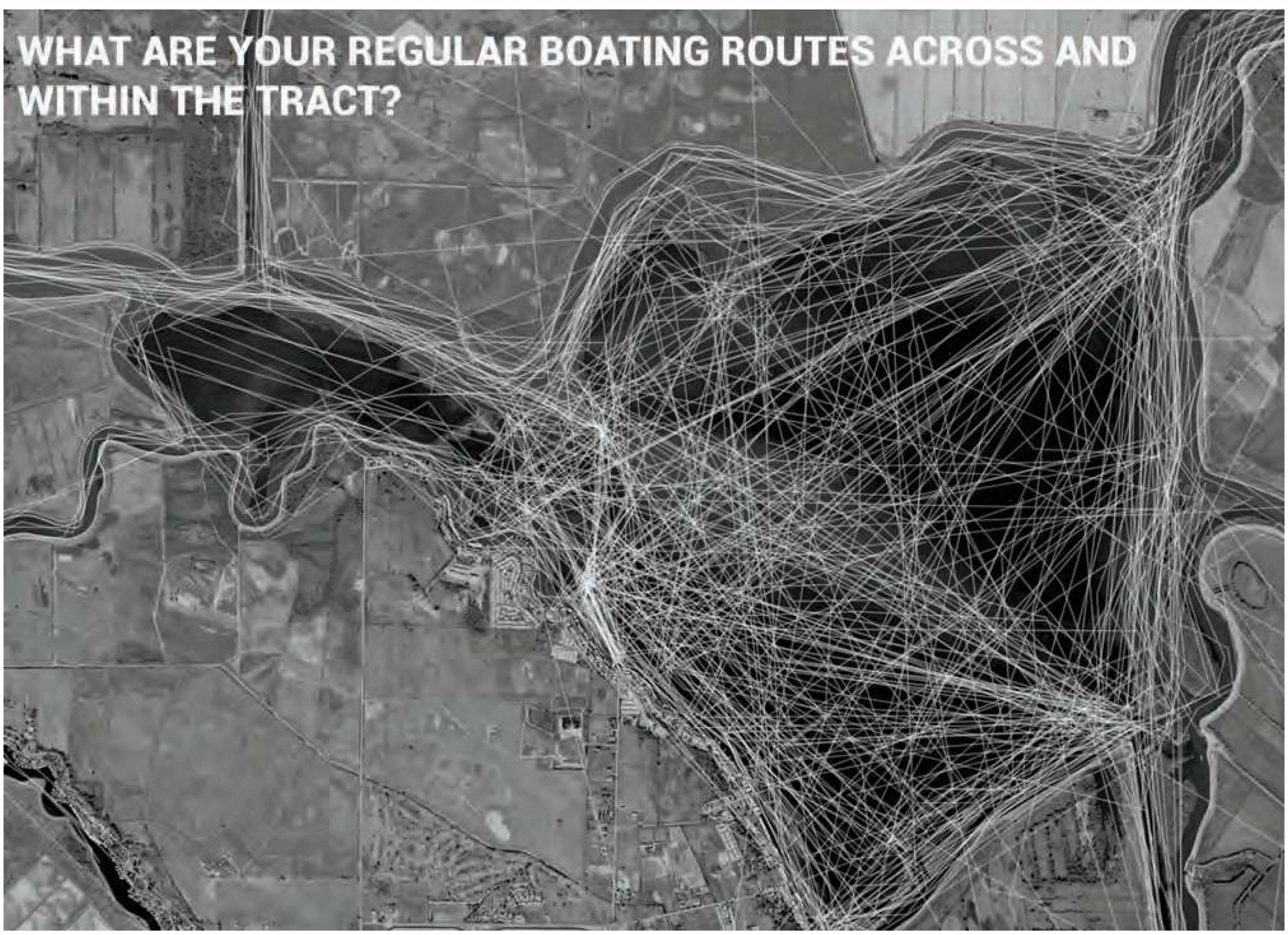
Geospatial Public Surveys, 2019-2020

To inform design concepts during the planning process, the team created and deployed two online public surveys. Both of these used Maptionnaire, a web-based, relatively easy-to-use, mobile compatible survey platform. This software allows survey participants to provide map-based, georeferenced and geo-specific information that can be uploaded to Geographic Information System (GIS) platforms for analysis (participatory GIS methods, or PPGIS).

The first survey, conducted in 2019 at the beginning of the second planning effort, was intended to assess current Franks Tract user preferences. The survey included map-based questions related to recreational activities, boating routes, launching and berthing, areas of potential improvement, and tidal marsh placement. Questions were informed by a previous survey conducted as part of the 2018 Franks Tract Futures feasibility study, which generated useful insights into the demographics and preferences of a substantial group of people who live, work, and play in and around Franks and Little Franks Tracts.

2019 Survey Results





The maps created from the first survey were thus crowdsourced and user drawn, rather than primarily authored, composed, or decided by the planning team. Participants were also asked to rank concerns and state their perspective regarding climate change in relation to the Tract. Findings from this survey are discussed Section 5 and provided in Appendix A.

The second survey, conducted in the summer of 2020, solicited comments and feedback on the concepts developed through the design development process. This survey relied on the same map-based platform and contained fly-through three-dimensional renderings of the design concepts as well as images of key proposed recreational and navigation features. The survey enabled participants to provide spatially explicit input on three design concepts and a No Action alternative. At the end, participants were asked to rank the four concepts. Findings from this survey are summarized in Section 5 and detailed in Appendix A.

Agency Presentations 2019-2020

The planning team made presentations of project goals, concepts, and processes to multiple state and regional agencies, including the Delta Protection Commission, the Delta Stewardship Council and the Collaborative Science and Adaptive Management Program to keep them informed of project activity and to solicit feedback. Presentations were also provided to interdisciplinary technical groups, such as the Interagency Ecological Program's estuarine ecology work team.

Looking Ahead

The project's engagement goals created and facilitated opportunities for stakeholders and members of the public to be integrally involved in the project planning and design process, from beginning to end. Indeed, public comments on the draft version of this report were used to revise and improve the final report. As stated before, designing with, rather than designing for, those who have a stake in the outcome was and is a top priority.

User interface of second survey showing one of the design concepts.

Common goals and objectives are critical to any successful planning, design, or decisionmaking endeavor. Over the course of the project, the planning team has worked with the Advisory Committee, Steering Committee, the public and the California Department of Fish and Wildlife (CDFW) to develop goals and objectives for enhancing Franks Tract and Little Franks Tract, and to design various concepts for landscape change that meet these objectives.

The design approach is based on input from these participants, as well as on past investigations, expert consultation, local user input, ecosystem restoration actions called for in various plans, and State Parks' General Plan. Additional input will be considered if and when a design concept is approved for further development.

The project team applied a Structured Decision Making (SDM) approach to guide and integrate technical design and engagement results during planning. This decision making approach seeks to guide groups of people working together on complex environmental and social planning problems in a way that is rigorous, inclusive, defensible, and transparent (Gregory et al. 2012).

Project Goals and Objectives

The goals of the Franks Tract Futures project are to enhance recreational opportunities and provide other community benefits, to support native and desirable species by re-establishing natural ecological processes and habitats, and to improve water quality. Project objectives elaborate on each of the goals (see table). Overall, the project seeks to find a balance of benefits across all objectives that will be sustainable over time. Together, these goals and objectives serve as the roadmap for redesigning the Franks Tract landscape.

Transparency in Project Scope

This project explores opportunities to achieve multiple benefits at many levels, from the community to the Delta region to the state, on Franks Tract. As an exploratory effort, no project "owner" or final decision-maker was identified up front. Any future project would require both local community and agency support to attract planning and implementation funding. The study funder, CDFW, was only one voice among many in a collaborative planning process.

Early on in planning, members of both the public and the Advisory Committee requested clarity on how the project related to water operations. Advisors wanted the project to be transparent in evaluating benefits and impacts under both existing water operations and potential future operations of interest to stakeholders, such as various conveyance alternatives including tunnels (to the extent they have been defined). While the California Department of Water

Project Goals

Resources is a project partner, with a primary focus on hydrodynamic modeling of enhancement scenarios, the Franks Tract Futures project has no influence over water operations, Delta exports, or proposals for alternate conveyance.

Structured Decision Making

The structured decision making approach guides groups of people working together on complex environmental and social planning problems such as Franks Tract stakeholders and communities. Careful attention is paid to separating judgments and deliberations about facts (such as outcomes that can be counted, measured or modeled) from judgments and deliberations about values (such as whether the benefits of an option outweigh its costs). As such, structured decision making facilitates the incorporation of important scientific and technical information into a formal deliberative options analysis process, with the aim of seeking consensus agreements on proposals and solutions.

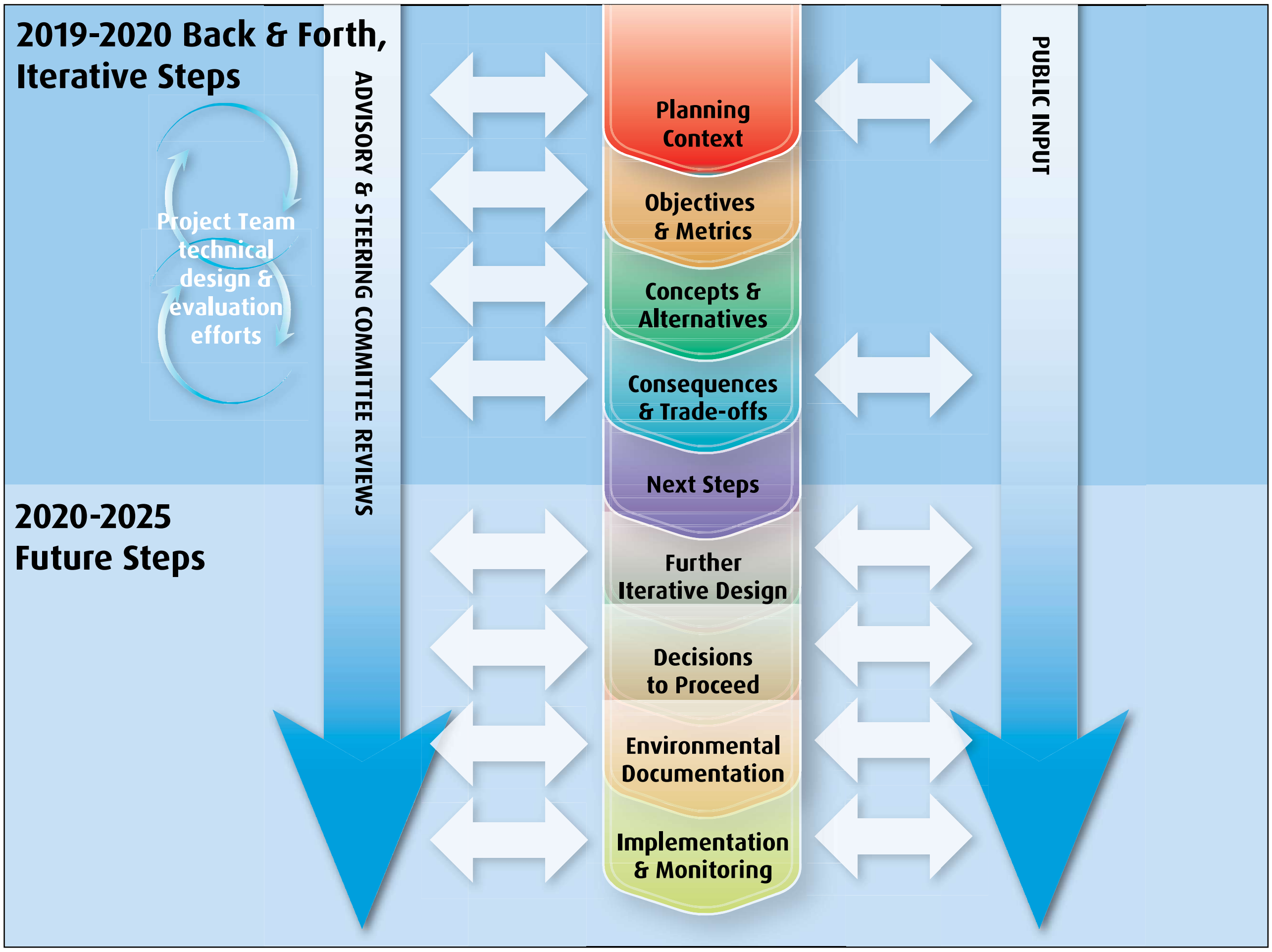
Basic iterative steps

- Clarify the decision making context – make clear what is in and out of scope, who the decision makers are, and how this planning process interrelates with other planning initiatives.
- Define clear goal, objectives and metrics – get to the root of 'what matters' and develop specific metrics (or evaluation criteria) that will be used to compare alternatives.
- Develop alternative concepts – iteratively develop and improve on the alternative concepts and detailed design features that best address the full range of objectives.
- Estimate consequences – use the best available data and analyses to describe how well the alternative concepts might perform with respect to the objectives and metrics, while documenting key uncertainties.

Objectives for Franks Tract's Future

Recreation	• Enhance recreation opportunities for fishing, motorized and non-motorized boating, waterfowl hunting, and shoreline recreation while minimizing impacts to existing recreational uses.
Navigation	• Minimize impacts to current boating travel times between key locations. • Maintain minimum depths for safe navigation around the Tract. • Reduce boating hazards and nuisance conditions.
Local Economy	• Maintain or enhance local economic benefits.
Ecology	• Maintain or enhance habitat for fish species of interest, specifically largemouth bass, Chinook salmon, striped bass and Delta smelt. • Minimize the risk of entrainment of special status fish species into Old River and the south Delta. • Minimize conditions that could result in the spread of undesirable invasive species. • Benefit a range of native species by establishing large areas of tidal marsh and associated habitats.
Water Quality & Supply	• Maintain or enhance water quality for human uses such as irrigation and drinking water. • Improve water supply reliability by reducing entrainment at the South Delta pumps. • Reduce the disruptions and costs associated with installation of emergency drought barriers.
Levee & Flood Protection	• Improve levels of flood protection, where possible, and avoid any adverse flood impacts.
Project Cost	• Minimize construction costs within the context of other project objectives. • Minimize long term total costs for ongoing operations and maintenance within the context of other project objectives.
Other	• Minimize impacts associated with project construction.

Reimagining Franks Tract



What's included in project scope?

In Scope	Out of Scope
• Full consideration of a No Action or "business as usual" alternative • Enhancement of opportunities for fishing, motorized and non-motorized boating, waterfowl hunting, and shoreline recreation • Navigation routes and boating travel times • Creation of tidal marsh for a range of ecological benefits • Control of undesirable aquatic invasive species • Potential water quality and supply reliability benefits • Wave sheltering of flood protection levees to reduce erosion risk • Local economic benefits • Consideration of alternatives representing a variety of CDFW, stakeholder and community interests	• Water operations decisions • Water quality standards decisions • Direct improvement of existing flood protection levees (indirect improvements from wave sheltering are in scope) • Local area infrastructure planning (roads, etc.)

- Evaluate trade-offs and preferences – evaluate the potential trade-offs and which alternative concept(s) deliver the best balance across the multiple objectives.
- Guide next steps – describe what the next steps in the planning process are, and – should a project move forward – how the detailed design, environmental documentation and implementation occur.

The decision making context and project goals and objectives (Steps 1 and 2) are described above. The planning team also developed detailed metrics for use in evaluating the performance of each proposed design concept relative to the project objectives (Step 2). Other sections in this report detail these metrics, as well as how alternatives were developed, consequences estimated, trade-offs and preferences evaluated, and next steps explored (Steps 3, 4, 5, 6).

From an engagement perspective, the project team planned workshops and outreach activities to extensively integrate stakeholders' interests, gather detailed input, share the consequences of different concepts with transparency, and openly engage in the discussion of potential trade-offs (see also Section 3).

Key benefits of this engagement approach

- Leveling the playing field – by explicitly defining everything that matters as objectives and distilling all technical analyses into an understandable set of evaluation criteria, everyone with a stake in the planning process can participate at an appropriate level, whether they have technical expertise or not.
- Facilitating joint learning – by transparently exploring a range of alternative design concepts and listening to expert and public opinions about any potential consequences and trade-offs, all participants learn together and actively contribute toward iterative improvements that seek to achieve the best balance for a feasible design.

From a technical design and analysis perspective, the project's team of experts in various fields applied the best available information and analysis methods to develop alternative designs. They then evaluated how concepts performed in achieving the project objectives, and refined specific design features (such as navigation channel widths and depths) based on committee and public feedback (see Section 5).

Key benefits of this technical approach

- Adding rigor and defensibility – while the technical analysis is still at the feasibility stage, a rigorous approach was taken toward each aspect of design and analysis, adding defensibility to the holistic planning process.
- Applying a structured framework – consistent and systematic methods of documentation and presentation enabled large amounts of information to be distilled into the key messages to inform judgements and understanding.

The figure on p. 27 shows how integrated planning, technical design and engagement unfolded over the duration of the 2019-2020 project as guided by the structured decision making approach. Over the year-long process, four formal workshops with the Advisory Committee and Steering Committee served as cornerstones of engagement as described above.

In sum, this report describes in detail how both engagement and technical design efforts have occurred in a collaborative, integrated manner. The next steps point toward a potential future planning phase in which further iterative design and environmental documentation would be developed with a similar commitment to engagement and collaboration.

Public workshop. Photo: UCD

5 Developing Design Concepts

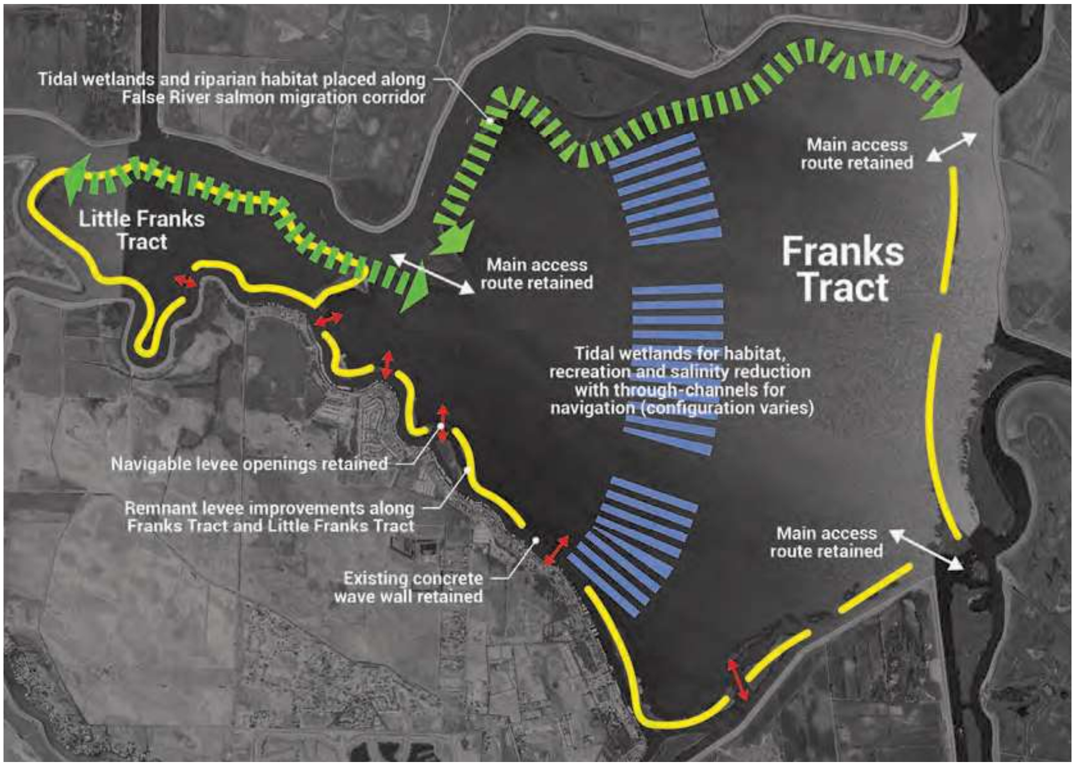
The Franks Tract planning team developed and evaluated a variety of different ways to achieve the project goals and objectives for enhancing this 3,300-acre flooded area. The process resulted in seven alternative designs for adding new land masses, redefining channels, and reshaping shorelines and levees. Each design concept integrated diverse features intended to improve public access, recreation, and water quality and supply reliability, as well as to enhance habitat for fish and wildlife.

The project generated four rounds of design concepts for review and evaluation by the Advisory and Steering committees, the public, and team experts (see also Sections 3 and 4). The team began by screening seven initial concepts, then developed three concepts in more detail, then refined those concepts. Each round included a No Action alternative for comparison. The year-long process — which occurred between the summers of 2019 and 2020 and included workshops, charettes, surveys, and questionnaires — culminated with selection of one preferred concept by the committees and the public.

Features Common to all Design Concepts

To guide development of the design concepts, the planning team began by identifying the following preliminary list of common features that would be a part of any future for Franks Tract (see figure below).

- Retain the existing breaks in the remnant levee between Piper Slough and adjacent Franks Tract open water and in select additional locations for navigation.
- Retain the existing fast water navigation paths in approximately their current positions, as much as possible.
- Retain the existing Bradford Island Ferry location.



- Create extensive tidal wetlands and deepened open water areas to enhance habitats for native fish and popular sport fish. Re-establishing tidal marsh and associated channels will require raising selected areas 8 to 11 feet.
- Enhance Chinook salmon habitat by creating a band of tidal wetland along the False River channel (in green). Tidal marsh in these areas will provide places for salmon fry to feed and grow. The wetlands will also provide refugia for juvenile Chinook salmon along their outmigration path.
- Enhance habitat for Delta smelt by creating open water, and possibly turbid areas, fringed by tidal marsh in Little Franks Tract, closest to primary smelt habitats in the west Delta.
- Reduce the potential for aquatic invasive plants by converting existing shallow water areas to intertidal marsh and deep water (borrow) areas (see Background Primer, p.14).
- Limit or otherwise manage exchange of flow between the northwestern part of Franks Tract at the "nozzle" and the southeast corner at Old River to improve water quality, reduce entrainment of regulated fish, and improve water supply reliability. In general, this means locating restored marsh or a berm to divide the Tract in two between these locations.
- Build up the remnant Franks Tract and Little Franks Tract levees to provide wave sheltering for adjacent (maintained) levees on Bethel Island and other adjacent islands.
- In general, Little Franks Tract is prioritized for non-motorized boating and native fish species, while Franks Tract proper is prioritized for sport fish, motorized boat recreation, and destination beach and recreational areas.


Photo: Brett Milligan

Four Rounds of Design and Public Input

Round 1 Concepts

At the first Advisory and Steering Committee workshop on August 29, 2020, participants provided input on the project goals and objectives, the No Action alternative, and the first round of seven design concepts presented by the planning team (see timeline opposite). These "Round 1" concepts built on earlier concepts developed for the 2018 Franks Tract Futures feasibility study, including the locally preferred plan, and those developed for a 2018 landscape design studio hosted by UC Davis with select stakeholder and state agency input.

An interactive design charrette enabled participants to discuss and evaluate the seven Round 1 concepts, providing useful and detailed input on preferences and concerns about each one. The planning team used input from the design charrette, as well as written evaluation forms, to rank least and most preferred concepts and to refine concepts for the next round. The four concepts that moved forward in design and evaluation (Round 2), in order of most to least preferred (1-4) were:

1. Eastern Landmass and Central Island
2. Central Landmass
3. Combination of the Open Water Berm and Channel concept and Bays and Channels concept
4. No Action Alternative

The team dropped two designs after the first round of evaluation. The "light touch" or No Action Alternative Plus concept, which included dredging and levee fortification, failed to move forward because it did not meet water quality and ecological goals. The northern archipelago was dropped because participants did not like the layout of tidal marsh directly in front of Bethel Island for aesthetic and navigability reasons, as well as concerns for property values. This concept was also unlikely to meet the water quality goals.

Round 2 Concepts

For the second Advisory and Steering Committee workshop on November 6, 2020, participants provided input on three Round 2 concepts and the No Action alternative. In addition to design review, participants reviewed and commented on draft evaluation methods and criteria (see opposite). The planning team presented three more detailed and refined concepts for improving Franks Tract. Refinements reflected technical input for constructability, initial assessment of water quality improvements, and further detailing of potential public access features.

Over 14 months, the planning team worked through a public process on four rounds of concepts for redesigning Franks Tract. The first round consisted of 7 potential project designs plus the No Action (no project) alternative. Input from committees and the public narrowed the field down to 3 designs, and more recently to a preferred concept (see next page).

Co-Design Timeline 2019-2020

2019

07/11 Kick off Meeting (public)

Project background and planning process overview.
Introduction to ESA-led team and overall project approach.

08/29 The First AC/SC Workshop

Reviewed and received input on the project goals and objectives
Reviewed and received input on the No Action alternative scenario
Shared the initial results of the (online) Stakeholder Survey
Conducted a design charrette to receive input on the first round of design concepts

ROUND 1

Concept 1 - No Action | Concept 2 - Light touch | minimal project | Concept 3 - Open water berm and channel | Concept 4 - Northern archipelago

Concept 5 - Bays and channels | Concept 6 - Central land mass | Concept 7 - Eastern landmass and central island

11/06 The Second AC/SC Workshop

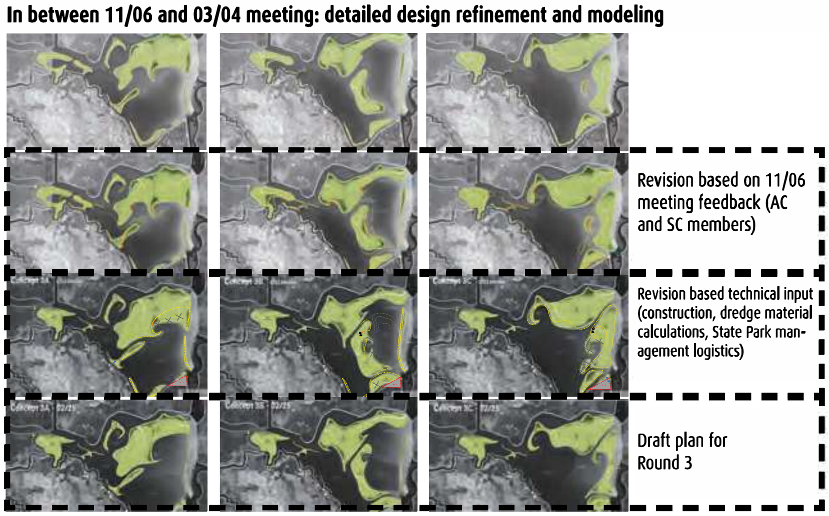
Reviewed and received input on the revised design concepts
Reviewed and received input on the draft evaluation methods and criteria
Shared the initial results of hydraulic modeling, received input on the initial recreational features design ideas and marsh aesthetic surveys
Conducted a design charrette to receive input on the next round of design concepts

ROUND 2

Concept 2A - Open water berm and channel | Concept 2B - Central land mass | Concept 2C - Eastern landmass and central island

ROUND 3

In between 11/06 and 03/04 meeting: detailed design refinement and modeling

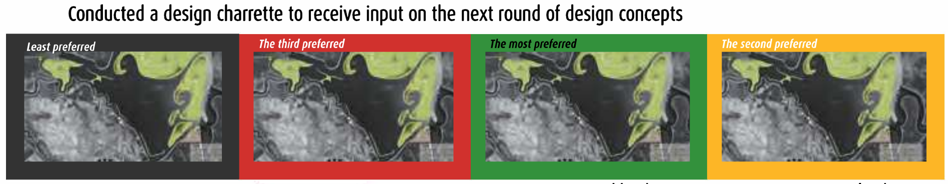


2020

03/04 The Third AC/SC Workshop

Reviewed and received input on the revised, 3rd round of design concepts
Reviewed the performance of the three concepts in meeting the project objectives
Conducted a design charrette to receive input on the next round of design concepts

ROUND 4



Concept 1 - No Action | Concept 3A - Open water berm and channel | Concept 3B - Central land mass | Concept 3C - Eastern landmass and central island

process is ongoing

Evaluation of the Round 2 concepts suggested:

- Design of Little Franks Tract could be held consistent between all concepts for ecological benefits and as a focal area for non-motorized recreation,
- The entry to Franks Tract from Roosevelt Cut in the southeastern part of the site should be reconfigured to improve navigability at a dangerous boating intersection and to improve the quality of water moving into the south Delta,
- The widths of the through-channels – the channels that allow boat access between land masses onsite – are critical to navigation and require further hydrodynamic modeling to identify the appropriate balance between fast-water navigation safety and water quality benefits,
- The size of tidal marsh landmasses should be reduced to limit the amount of fill material and associated costs.

Feedback on the Round 2 concepts during the charrette, and results of a written questionnaire completed by workshop participants, indicated a shift in preference to the Central Landmass, or Concept 2B. Members of both committees liked the combination of open water adjacent to Bethel Island; relative proximity of the beaches, day use area and other land-based recreational features to Bethel Island (compared to the Eastern Landmass); and the creation of two open water areas, each relatively protected from waves since the central landmass would shelter the eastern open water area, which is currently prone to waves. The second preferred concept was the eastern landmass, or Concept 2C, followed by the open water berm and channel, Concept 2A. The No Action alternative remained the least preferred.

Rounds 3 and 4 Concepts

The planning team presented three Round 3 revised concepts and the No Action alternative at the third Advisory and Steering Committee workshop on March 4, 2020. In the presentation, the team retained the general approach of the Round 2 concepts - open water with berm, central land mass and eastern landmass – but made refinements to the through-channel widths, recreational features, and other adjustments to improve project performance.

After another workshop, the team made minor adjustments to the Round 3 concepts. To avoid confusion, the project team called these the Round 4 concepts, though they are very similar to Round 3.

Rating the Design Concepts

In the evaluation process, the planning team developed a detailed set of metrics, or evaluation criteria, to measure the performance of each design concept relative to the eight project objectives (see Section 4). Technical experts on the team then rated concepts with respect to each objective based on detailed site conditions, hydrodynamic model results, and input from committee members with specific expertise. To help facilitate overview comparisons, the team summarized evaluation criteria for each project objective using a 1 (worst) to 10 (best) rating scale. The team solicited committee member and other stakeholder input to develop the evaluation criteria and ratings.

By way of example, one navigation objective is to minimize impacts to current boating travel times between key locations. Planning team members worked with local boaters on the Advisory Committee and used data from the project's User Survey to identify six key travel routes through the site. They measured and compared the distance of each of these routes for each project concept and the No Action alternative. Since the project commitment is to provide fast water access along these routes (e.g., no "no wake" zones), distance is considered a reasonable proxy for relative travel time. The team then rated overall performance for travel distance on a 1 to 10 scale for comparison between concepts.

Using this overall approach, the team created a summary consequence table rating each concept based on each primary objective (see p. 29). All consequence tables were color-coded on a scale from worst (1-red) to best (10-green). The range of scales and colors is based on all seven concepts evaluated during the iterative planning process. At a glance, the colors highlight potential trade-offs and the need for detailed discussions.

Ratings and evaluations provided in the following pages refer to Round 4 concepts. Ratings were updated with each round of concept development.

Ultimately, how one design concept and vision for Franks Tract's future layout compares to another depends on the values attached to different aspects of concept performance. Values vary by individual, reflecting their individual priorities.

At the highest level for consideration, overall ratings indicate that a redeveloped Franks Tract offers an opportunity for improvements in recreation, ecology, and water quality and potentially other objectives. Of course, the evaluation also finds there would be some unavoidable trade-offs, especially with respect to costs and construction impacts. More details and finer scale considerations are explored in the following tables (see p.29) as well as Appendix A.

OVERALL SUMMARY

Worst — Best

At the highest level for consideration, a redeveloped Franks Tract offers an opportunity for improvements in recreation, ecology, and water quality and potentially other objectives. Of course, the evaluation also finds there would be unavoidable trade-offs, especially with respect to costs and construction impacts. More details are explored in the following tables. A complete description of evaluation criteria and ratings can be found in Appendix A.

Objectives	No Action	Concept A	Concept B	Concept C
Navigation	7.4	6.1	7.2	7.3
Recreation	2.3	5.3	6.1	5.6
Local Economy & Community	4.5	5.2	6.2	6.4
Ecology	2.5	6.0	6.2	6.0
Water Quality & Supply Reliability	3.3	7.3	7.0	6.7
Flood Protection	4.0	7.5	7.5	7.5
Construction Impacts	6.0	4.0	4.0	4.0
Total Cost: Construction and O&M	$	$$$	$$$	$$$

NAVIGATION

Project objectives call for minimizing impacts to current boating travel times between key locations and improving boating safety. Ratings from the evaluation confirmed that the current wide-open Franks Tract offers the shortest travel distances in any direction. Next best, in order of performance, were design Concepts C, B and finally A, which would create the largest increase in navigation distances. These potential increases need to be weighed against improvements to boating safety within the Tract, with the three concepts maintaining minimum depths for safe navigation and reducing boating hazards. Another important consideration will be potential increases in conflicts between fast water navigation and recreation activities in any new multi-use recreation area.

Objectives	No Action	Concept A	Concept B	Concept C
Navigation	7.4	6.1	7.2	7.3
Travel Distance	10.0	6.4	8.4	8.8
Boating Safety	4.7	5.7	6.0	5.7

RECREATION

Project objectives call for enhancing recreational opportunities for fishing, boating, waterfowl hunting, and shoreline recreation, and minimizing impacts to existing recreational uses. Ratings from the evaluation suggest diverse recreational opportunities (such as beaches, mooring sites, and shoreline access) could be designed into any of the three new concepts, with Concept B offering the greatest opportunity for sheltered open water boating areas. In terms of fishing, the rating is based on both sportfish habitat and access to a quality fishing experience (potential changes to the fishing experience warrant further review). In terms of the future hunting experience, which could include both open water and marsh-based blinds, further input from the hunting community is still needed on how this new, more diverse system would work best.

Objectives	No Action	Concept A	Concept B	Concept C
Recreation	2.3	5.3	6.1	5.6
Fishing	5.1	6.0	6.2	6.3
Motorized Boating	2.0	5.0	8.0	5.0
Non-Motorized Boating	1.0	5.5	5.5	6.0
Shoreline Recreation	1.0	4.5	4.5	5.0
Waterfowl Hunting				

LOCAL ECONOMY

Project objectives call for providing local economic benefits where possible and for minimizing disruptions to the local economy and community. Ratings from the evaluation, with a specific focus on Bethel Island, suggest significant interest in maintaining or improving effects on local businesses, real estate and aesthetics. One aesthetic priority is to preserve current open water views from Bethel Island. Each concept rates differently in that regard, but all preserve open water adjacent to Bethel Island. All concepts would add naturalistic features to views, like tidal wetlands, and reduce nuisance aquatic weeds, both considered potential benefits. Both real estate values and local business effects are seen to be linked with these aesthetic conditions, as well as being dependent on the overall navigation and recreation opportunity ratings discussed above.

Objectives	No Action	Concept A	Concept B	Concept C
Local Economy & Community	4.5	5.2	6.2	6.4
Business Effects	4.9	5.7	6.7	6.5
Real Estate	4.6	5.4	6.3	6.4
Aesthetics	4.0	4.7	5.7	6.3

ECOLOGY

Project objectives call for benefits to both native and sport fish by creating tidal marsh and other habitats, reducing the spread of undesirable invasive species, and minimizing the risk of entrainment of special status species into the south Delta. Ratings from the evaluation suggest that all three new concepts present a significant opportunity to improve the overall ecological conditions, especially for special status native species (Chinook salmon, Delta smelt). The area supporting aquatic invasive species would also be reduced, another improvement in conditions. How the concepts would change conditions for sportfish needs more evaluation. While the overall sportfish ratings for the three concepts compare fairly evenly with the No Action Alternative, there would be a significant shift away from open-water shallow habitat toward more open-water deep-to-shallow edge and marsh-edge habitats with increased velocity gradients.

Objectives	No Action	Concept A	Concept B	Concept C
Ecology	2.5	6.0	6.2	6.0
Special Status Species	2.5	6.8	6.2	6.2
Sportfish Habitat	5.4	6.2	6.5	5.8
Conditions for Native Species	1.0	4.0	5.0	5.0
Conditions for AIS Spread	1.0	7.0	7.0	7.0

WATER QUALITY

Project objectives call for enhancing water quality for human uses (such as irrigation and drinking water), improving water supply reliability by reducing fish entrainment at the water project pumps, and reducing disruptions associated with emergency drought barriers. Ratings from the evaluation suggest improved water quality and supply reliability with all three new concepts performing much better than the No Action alternative. There would be improvements in salinity conditions for water use and consumption under a variety of flow conditions, as well as a net reduction in potential entrainment of protected fish, which currently limits the reliability of water operations. In addition, the project is projected to reduce the need for salinity control barriers on False River under severe drought conditions.

Objectives	No Action	Concept A	Concept B	Concept C
Water Quality & Supply Reliability	3.3	7.3	7.0	6.7
Water Quality: Human Uses (salinity)	3.0	8.0	7.0	6.0
Emergency Drought Protection	2.0	7.0	7.0	7.0
Supply Reliability (entrainment)	5.0	7.0	7.0	7.0

Worst Best

FLOOD PROTECTION

Project objectives call for improved flood protection, where possible, and avoidance of any adverse flood impacts. Ratings from the evaluations suggest all three concepts would benefit flood protection levees by enhancing remnant historic levees around the Tract that provide wave sheltering. Flood modeling suggests that none of the three project concepts significantly alter high water levels compared to the No Action alternative.

Objectives	No Action	Concept A	Concept B	Concept C
Flood Protection	4.0	7.5	7.5	7.5
Sheltered Levee	3.0	10.0	10.0	10.0
Flood Risk Reduction	5.0	5.0	5.0	5.0

CONSTRUCTION

Project objectives are to minimize or mitigate construction impacts in both the near and long term. Ratings from the evaluation leave no doubt that the construction period for any of the three proposed concepts would have near-term impacts on the local community and use of Franks Tract. Activities such as dredging and materials transport would be ongoing over a period of years, as would noise and changes in navigable routes. Staging future construction to accommodate tract uses and key hunting or fishing periods could help mitigate impacts. On the benefit side, as discussed above, the project would reduce periodic impacts over the long term from construction of emergency drought barriers.

Objectives	No Action	Concept A	Concept B	Concept C
Construction Impacts	6.0	4.0	4.0	4.0
Construction Period Impacts (short term)	10.0	1.0	1.0	1.0
Drought Barrier Impacts (long term)	2.0	7.0	7.0	7.0

PROJECT COSTS

Project objectives call for minimizing construction costs, as well as long term operations and maintenance costs. Though detailed cost estimates are not yet available, any evaluation would conclude that both construction and long-term operations and maintenance costs would be much higher for any of the three Concepts relative to the No Action alternative. As described above, however, the project would reduce long term costs for levee maintenance, and drought barrier construction and removal. Costs could potentially be reduced for nuisance weed management. As the project evolves, 'who pays' needs to be aligned with the agencies and organizations with the most to gain. A commitment to long-term operations and maintenance funding would also need to be in place before any project could move forward. A major consideration for the project overall is whether the potential increased costs are warranted by the potential for multiple objective project benefits.

Objectives	No Action	Concept A	Concept B	Concept C
Total Cost: Construction and O&M	$	$$$	$$$	$$$
Construction Costs	0.0	$$$	$$$	$$$
Operations & Maintenance Costs	$$	$$$	$$$	$$$

Arriving at a Preferred Concept

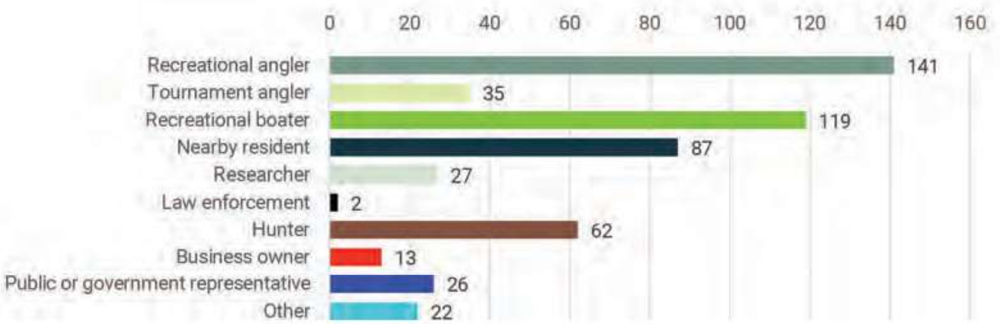
In spring 2020, the Advisory and Steering committees selected Concept B as offering the best balance between project objectives and the best opportunity to improve local conditions. According to the results of a written questionnaire completed by committee members in the March 2020 workshop, Concept B ranked first, followed in order of preference by C, A and the No Action alternative. In Concept B, committee members like the combination of open water adjacent to Bethel Island; relative proximity of the beaches, day use area and other land-based recreational features to Bethel Island; and the creation of two open water areas, each relatively sheltered from waves. This preference was confirmed based on the evaluation and rating results, as interpreted and weighed through the values of each committee member.

Later in spring and summer of 2020, the planning also solicited public preferences, comments and questions on the design concepts and No Action alternative through an online survey platform. Some of the results of the survey appear in the charts and maps on the following pages, but are detailed in Appendix A.

The survey asked respondents to rank the three landscape design concepts and the No Action alternative (NAA) for Franks Tract in terms of preference on a scale of 1-4. As shown in the chart below on average, the NAA was the lowest-ranked, but only by a small margin with concepts A and C slightly more preferred. Currently. Design Concept B (Central Landmass) is the most preferred by survey respondents, which was also the most preferred concept among the Advisory and Steering committees. The committees' Concept B was preferred by a considerably larger majority, however.

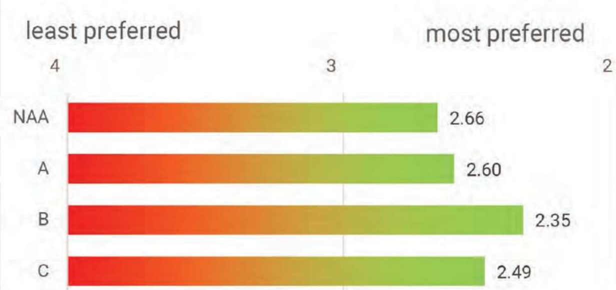
Which of the following categories do you most identify with? (multiple answers can be given)

Total single category count



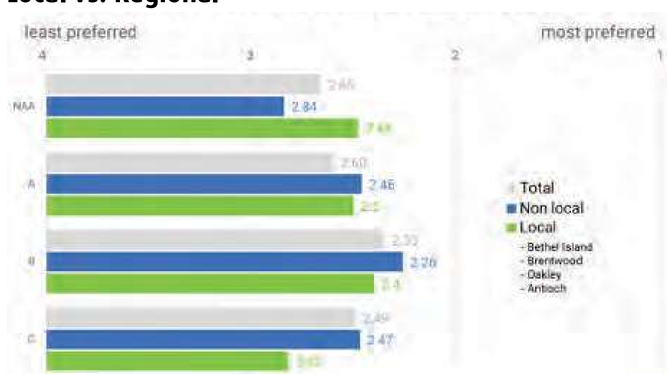
Users were asked to pick multiple categories they identify with, which resulted in a plethora of hybrid categories (see Appendix A).

Final Rankings of Design Concepts from Public Survey



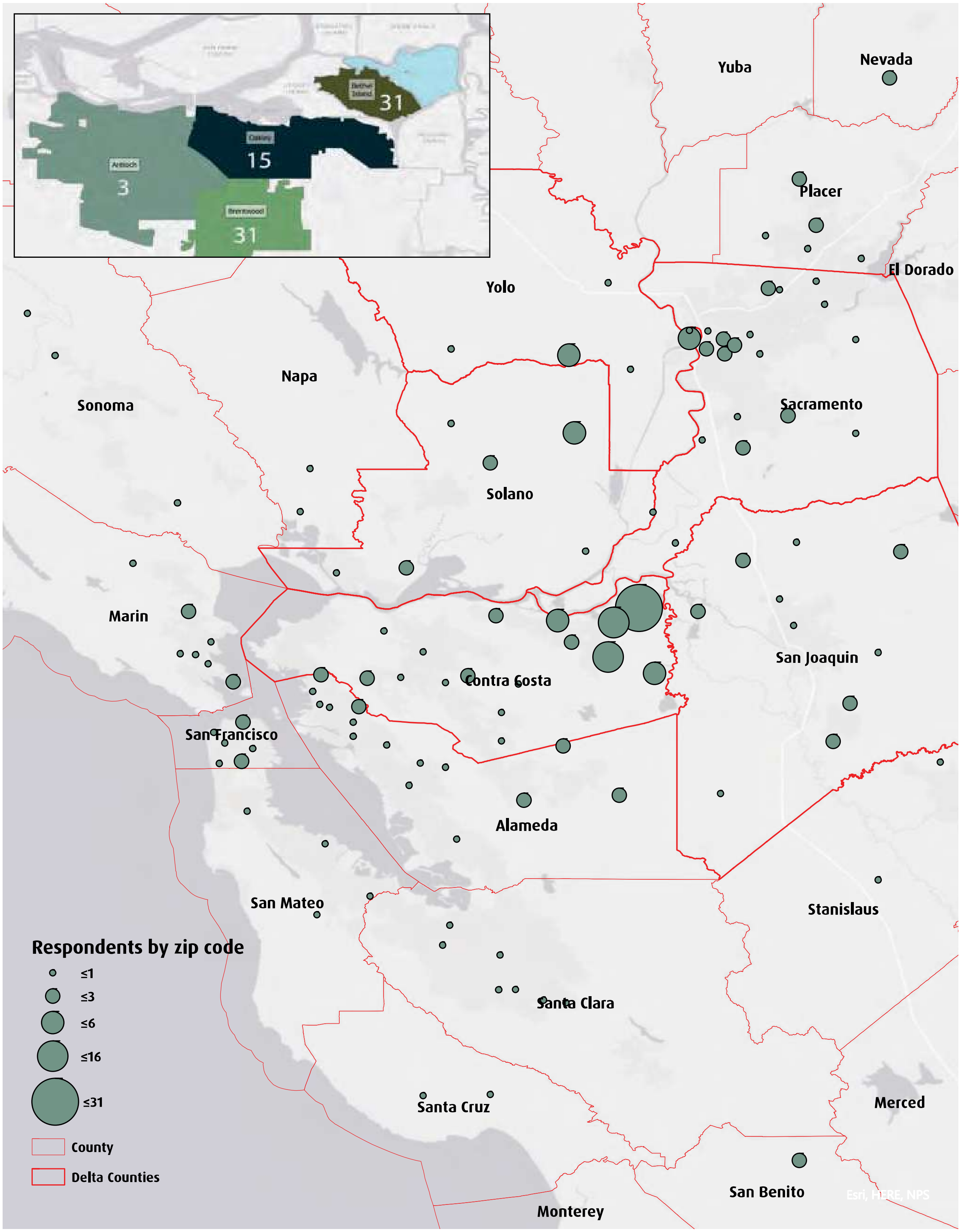
Concept B was the most preferred design by survey respondents. On average, there was similar support across the NAA and concepts A through C. Although 36 (39%) respondents chose the NAA as their most preferred option, over two times as many people (75) selected at least one of the three design concepts as their most preferred, suggesting significantly higher preferences overall for the design concepts.

Overall Comparative Ranking of Design Concepts: Local vs. Regional



Ranking based on the respondent's zip code location,comparing local (Bethel Island, Oakley, Antioch, Brentwood) responses (32%) to non-local respondents (68%). The preference for the NAA was slightly higher among local respondents compared to non-local. A similar difference was observed between respondents from Delta and non-Delta Counties. Thus although the overall top preference for Concept B was consistent across all geographic scales of respondents (local, Delta, and regional) preference for Concept B was greatest at the regional scale.

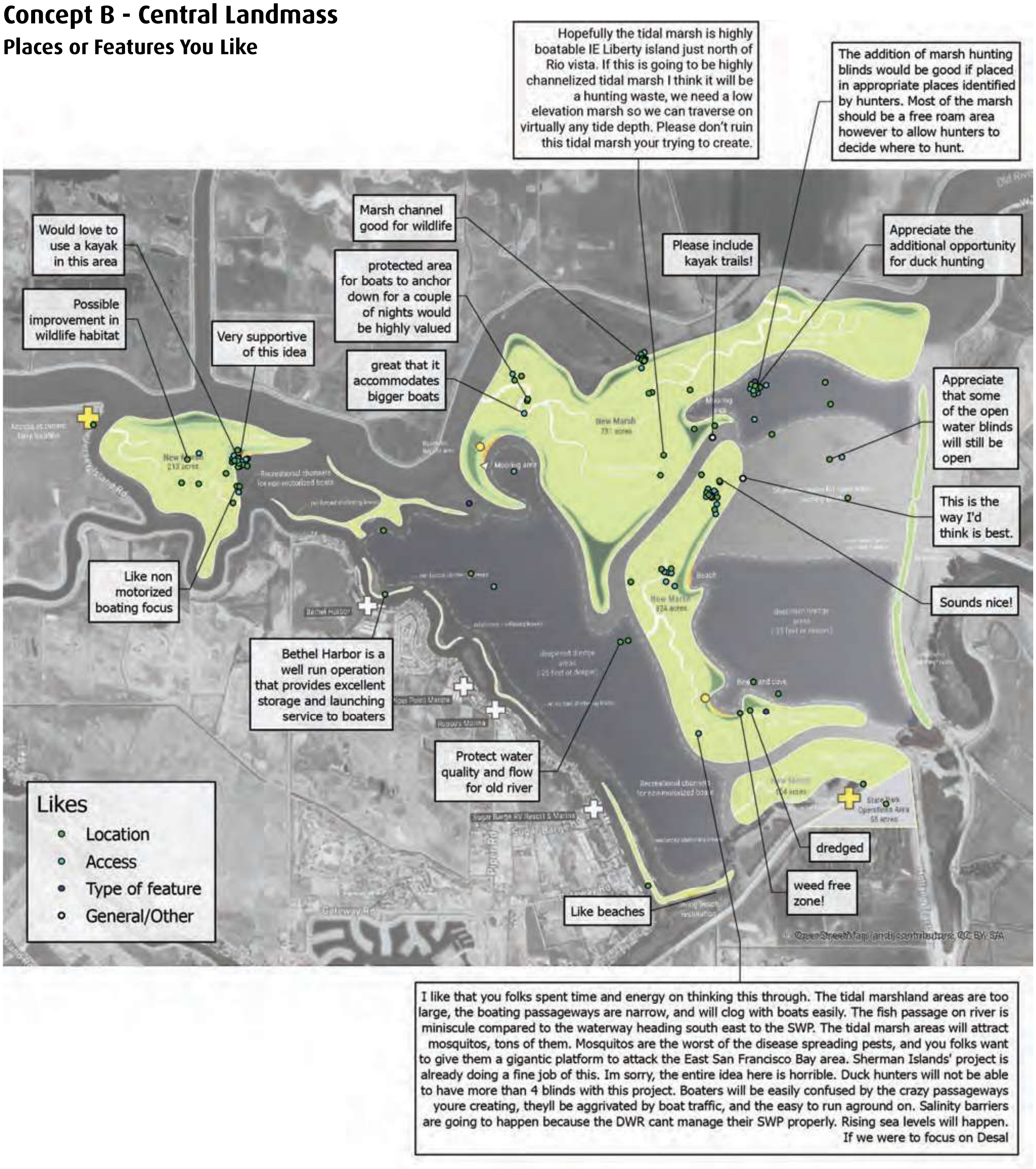
Residential Zipcode of Survey Respondents



Map showing survey respondent count by zip code. Delta counties are shown in darker red. Approximately 72% of respondents listed a zip code located within a Delta County; 32% of respondents were from Bethel Island, Brentwood, Oakley, or Antioch, and therefore considered local.
INSET: Number of local survey respondents (in white) from the cities of Bethel Island, Oakley, Antioch, Brentwood), which we defined as 'local' to Franks Tract for the survey analysis. Together these local cities accounted for approximately ⅓ of respondents.

Concept B - Central Landmass

Places or Features You Like

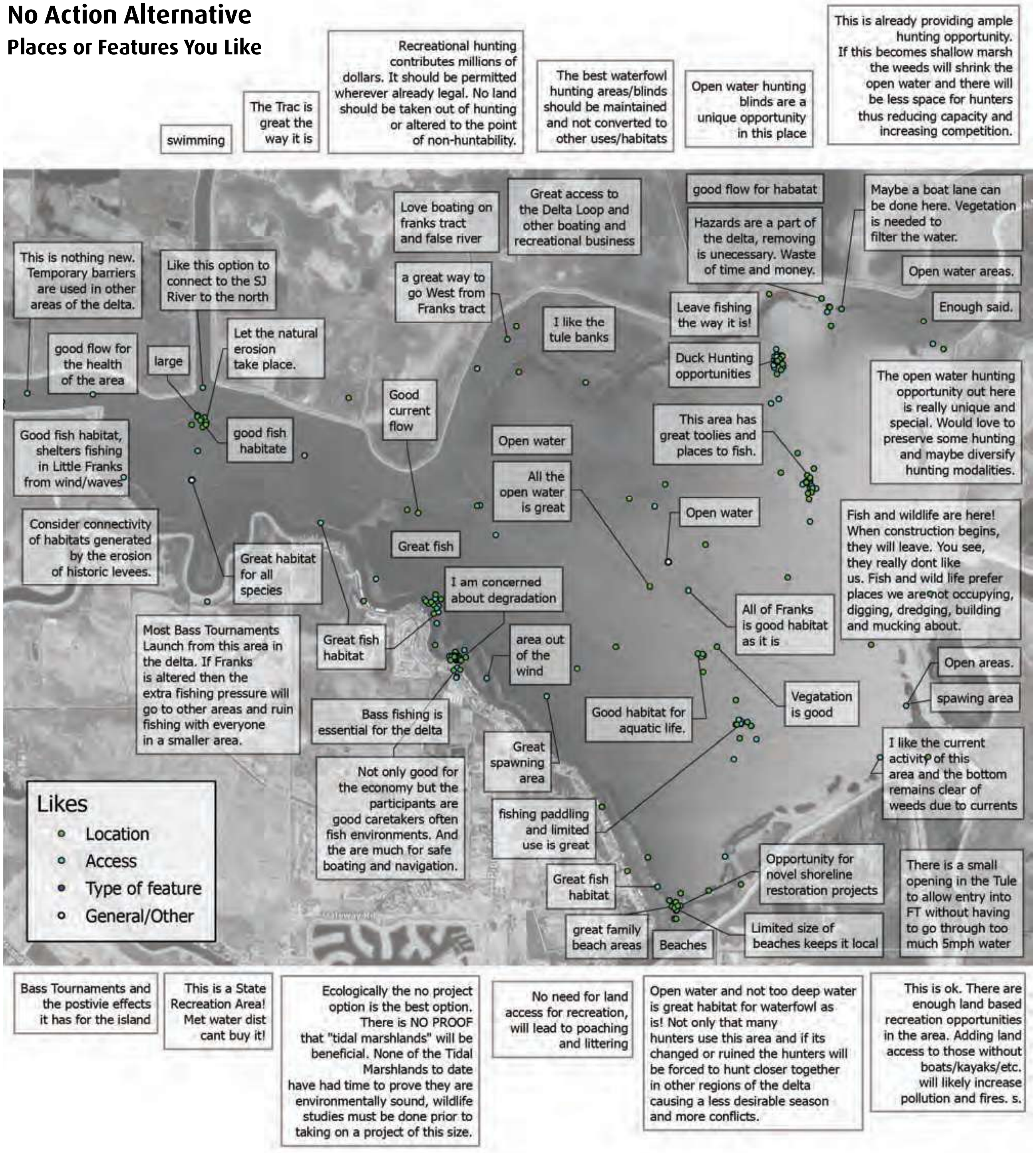


Interactive Mapping Responses

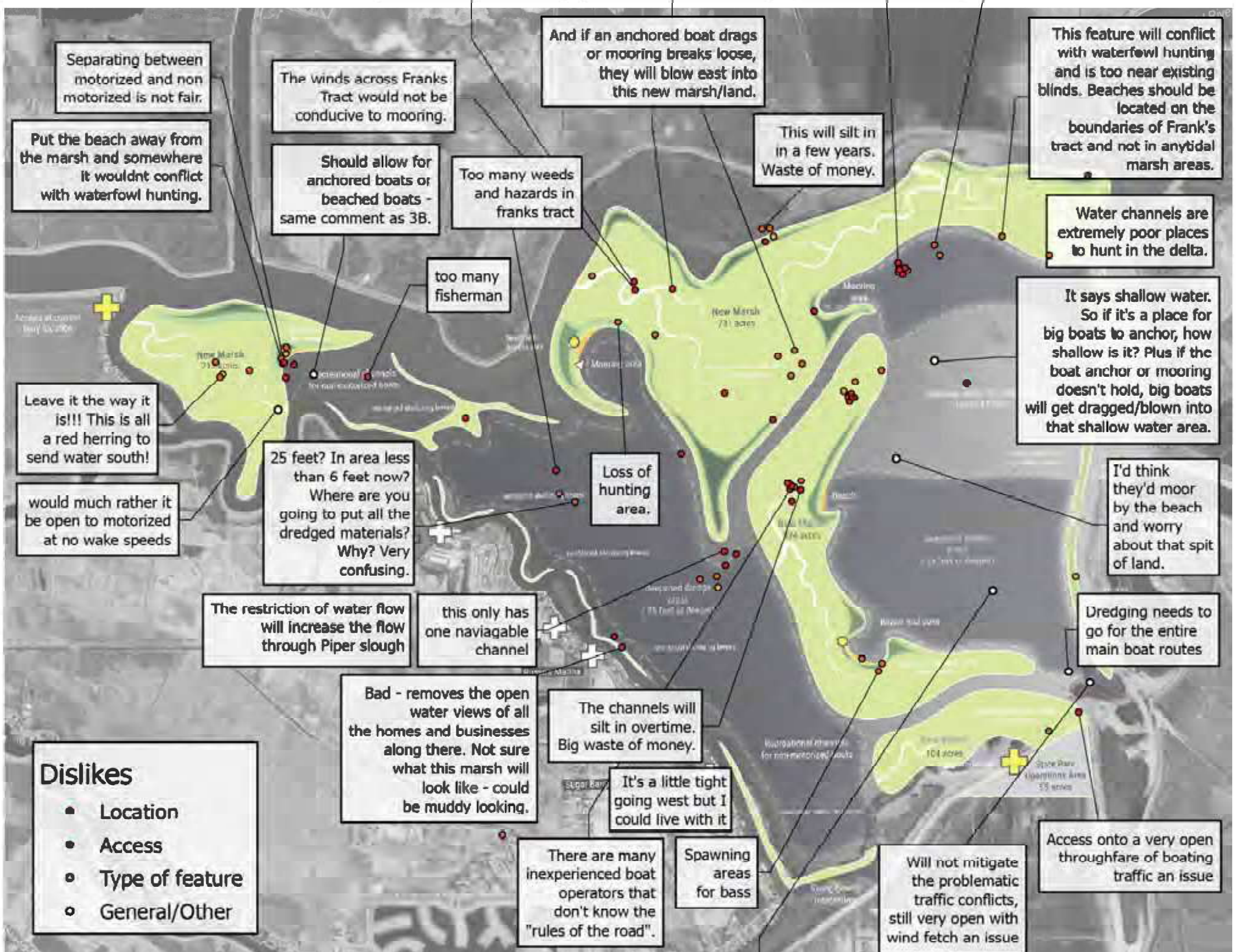
The planning team asked survey participants to mark the places and features they liked and disliked on interactive computer maps of all three design concepts, as well as the No Action alternative. Upon placing a pin, participants were asked as multiple choice questions on why they liked or disliked a feature.

The choices for the like and dislike related to location, feature, and access. Participants were also given the opportunity to make other comments and ask questions. The maps shown on these pages offer one set of examples of actual responses (see Appendix A for all 12 maps).

No Action Alternative
Places or Features You Like



Concept B - Central Landmass
Places or Features You Dislike

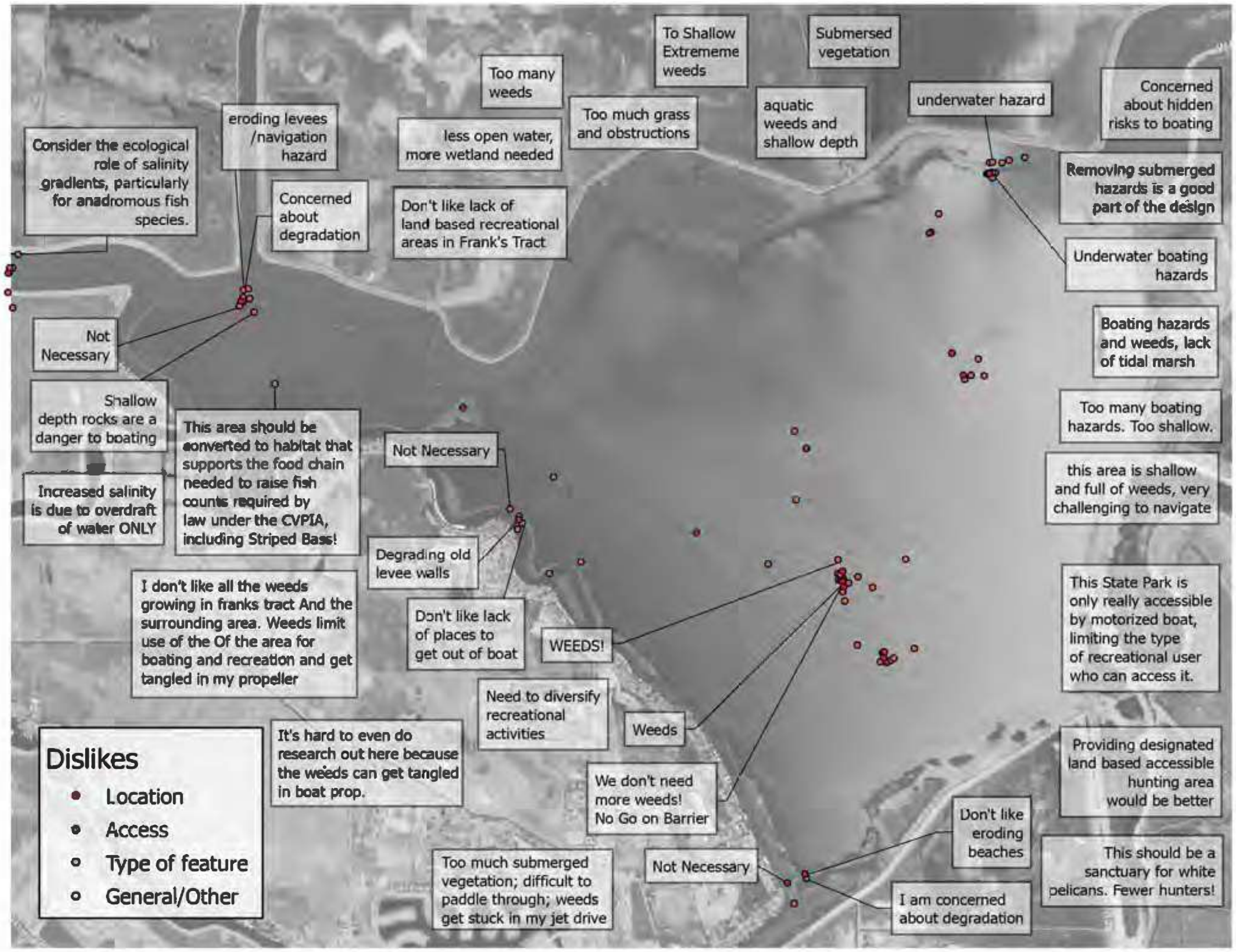


No Action Alternative

Places or Features You Dislike

So with regards to the vastness of the open water... It's boring to look at. It's flat open water with a fringe of riprap levees. Would love aesthetic improvements of seeing marshes or even trees on the horizon instead of huge expanse of nothing.

The current. Met Water District, the DWR and the rest of the SWP users were supposed to make efforts to DECREASE RELIANCE on Delta water. The pumps are sucking so hard, so much current is generated by them, its hard to back my boat out of its slip. They dont think we notice, but when the current is going the wrong direction, even though its timed USUALLY with tides, anyone that operates a boat can tell whats happening isnt natural. Getting the boat out isone thing, returning it to a slip when the pumps are working requires good aim, full throttle and a couple words with God when you slam the motors in reverse just before your boat hits the marina dock....



Submerged aquatic vegetation is a nuisance for research, recreation, and native species.

Change is needed. The flooded island is useless. It should be redesigned into the habitat necessary to boost the food chain that supported the once significant fisheries of just 50 years ago.

Take Homes from Map Mark Ups

The map-based survey results indicate that respondents provided substantial and detailed consideration (likes and dislikes) of the design concepts. This represents a significant change from the first survey for the initial feasibility study where most respondents provided only negative/dislike comments. Overall, some concerns still remain for a portion of respondents, and there are detailed design questions (such as placement of features, the design of tidal marsh land masses to optimize recreational and ecological benefits) that would need to be worked through, should the Franks Tract landscape redesign project progress forward. Based on results, the potential for a co-designed, multifunctional design concept that is able to preserve and enhance existing desirable features while developing new benefits is becoming more widely embraced.

Public Survey

Comment Summary from Map Mark Ups

No Action Alternative

When asked what they currently like in Franks Tract, respondents commented on fish habitat, fishing quality, bass tournaments, open water, waterfowl habitat, hunting opportunities, "good" vegetation, access and flow. When asked what they do not like in the Tract, respondents commented on aquatic weeds, shallowness, levee degradation, boating hazards, eroding beaches, the lack of access, dangerous currents, too much open water, salinity intrusion, and a need to diversify recreational opportunities.

Not everyone likes and dislikes the same thing. Some people find open water attractive while others prefer more marsh and shallowness, which is seen as necessary for good waterfowl habitat, but also creates boating hazards. The tract is large enough to support a diversity of features, including those where preferences are divided.

Overall Commonalities and Differences across the NAA and Design Concepts

Participants made supportive comments about the NAA focused on unique features such as open water, spawning areas, fishing, hunting, good flows, and access. Some respondents were concerned that these features might be lost or diminished if a design concept were implemented. Participants also made supportive comments regarding potential modifications that could enhance these unique existing features, address current concerns, and create new opportunities and improve Franks Tract.

Beaches were a common liked feature across the design concepts. However, there were concerns voiced about their proximity to hunting areas and the potential for them to become too popular and thus an attractive nuisance.

There was a recurrent concern voiced regarding the channel widths and navigability in the design concepts. Comments to this effect raised concerns about inexperienced boaters, the narrowness of the channels (and whether they would silt up over time), and the hazard created by adjacent tidal marsh.

In general, there was widespread support for the proposed modifications to Little Franks Tract. Some were concerned about the potential exclusion of motorized boats in the area, while others were supportive of the idea of exclusion in one portion of the Tract. Others questioned the accessibility of Little Franks Tract for non-motorized boaters.

Participants made many comments across all concepts related to hunting. Several voiced concerns about the potential eradication of existing hunting opportunities, where others appeared supportive of new marsh-based hunting opportunities, often contingent upon the resolution of access issues, and the inclusion of hunter preferences in the marsh habitat design.

The proposed modification to Holland Tip to improve navigation, which varied amongst concepts, drew many comments. Despite considerable efforts made in all the design concepts, with input from the advisory committee, to minimize risks and enhance safety, there remain concerns regarding fetch, wind, navigability, and traffic-related hazards at this dangerous corner.

Comments diverged regarding the benefits of creating marshlands and dividing the Tract into two separate water bodies. While many supported the idea based on improved navigability, habitat, and recreation, others were concerned about navigation, local businesses, aesthetics, and existing recreational opportunities. Concerns were voiced regarding mosquitoes and the marsh smell, which have been recurrent throughout the process.

Take Homes for Next Planning Round?

Based on respondent comments, the next round of planning should focus on the following:

- Resolving the issues related to the dangerous corner at Holland Tip.
- Including duck hunters, and others in the design and management plans for the proposed marshlands.
- Continuing to include stakeholders in discussions related to marsh aesthetics and the experience of boating through a channel between landmasses.
- Discussing conflicts between potential recreational activities and creatively imagining solutions based on the separation of conflicting activities by distancing them in time and space.
- Undertaking further detailed design of land-based recreation opportunities such as picnic areas, campgrounds, wildlife viewing platforms, etc.
- Developing a clearer design for a State Parks facility somewhere in the vicinity of the Tract. Holland Tip has been identified as a potential location, however, there may be others, such as Jersey Island that may warrant consideration as well.
- Building upon the significant consensus regarding the design of Little Franks Tract, consider key issues including non-motorized boating access; possible exclusion of motorized boating; habitat value for smelt and other desirable species; relationship to Jersey Island and Bradford Island, and the ferry connecting the two (including maintaining the Bradford Island terminal).

6 Preferred Design Concept

Overview

The project design for Franks Tract and Little Franks Tract establishes a large area of intertidal marsh with channels, deepens open water areas to discourage nuisance submerged aquatic vegetation, and creates water and land based recreational opportunities. The design attains all project goals, discussed in detail throughout this section.

The preferred design concept was chosen by stake-holders, advisors, and the public after a year-long collaborative process (see Sections 3-5). The preferred concept creates two, large open water areas in Franks Tract, connected by tidal wetlands and deeper navigable channels. The eastern water body features sheltered coves and recreational features, with the marsh land-masses helping to reduce prevailing winds and waves.

Re-establishing tidal marsh and associated channels would require raising selected areas 8-11 feet as Franks Tract is currently subsided below sea level. Water depths at the lowest tides range from 6-8 feet (MLLW). To fill proposed new landmasses to elevations where marsh plants can grow, some areas of the Tract would be dredged (see Section 7).

The preferred concept would restore 1,370 acres of intertidal habitats, marsh and tidal channels within Franks Tract and Little Franks Tract. About 1,900 acres of shallow water (less than 6-8 feet) and 1,000 acres of deep open water would remain on the Tract.

KEY ELEMENTS OF THE DESIGN

Build a central tidal marsh landmass which maintains open water in front of Bethel Island, creates accessible land-based recreation, and impedes salt water movement from the western Delta to the south Delta.

Use over 37 million cubic yards of on-site fill material to create approximately 1,370 acres of emergent marsh, tidal channels, and associated upland habitat and 1,000 acres of deep water (greater than 20 feet) habitat.

Creates approximately 21 miles of tidal marsh channels.

Create 5 sheltered beach locations.

Establish a designated non-motorized recreational area.

Improve 12 miles of remnant levees around Franks Tract and Little Franks Tract to shelter flood protection levees and adjacent waterways from waves.

Recreational access would be maintained from the Bethel Island marinas. Additional public access is proposed at a new 55-acre State Parks Operations Area at the northern tip of Holland Tract.

The project design also divides the Tract in a way that improves water quality conditions and reduces salinity intrusion in the central Delta while maintaining navigation routes through Franks Tract to surrounding areas from Bethel Island. One big change in the landscape configuration from earlier (2018) designs is that False River remains an open, navigable channel, with enhanced connection to new tidal marsh.

This chapter discusses how the preferred concept performs in meeting objectives for navigation, recreation, local economy, ecology, water quality and supply reliability, and flood protection. Construction objectives for the preferred concept are discussed in Section 7.

NAVIGATION

Overview

Franks Tract is heavily used and valued by boaters due in part to its fast water channels and easy access to multiple destinations. Boaters use Franks Tract as a way to get from one side of the Delta to another, taking many different routes to access a variety of locations. Creating the proposed tidal marsh landmasses within Franks Tract will affect most navigation routes, but properly located and designed channels through the future landmasses will allow fast water boating to continue.

Boating on Franks Tract does not come without challenges and dangers. Parts of Franks Tract are very shallow; many have become choked with aquatic weeds. In addition, remnant tree stumps and branches protrude above the water level at low tide, or worse, lie hidden right below the water surface. Other hidden hazards include degraded remnant levees and riprap. Boaters who are "in the know" avoid the worst of these areas, however new boaters are often caught unaware. The California Division of Boating and Waterways works to minimize weed growth and to remove weeds and boating hazards, however the high acreage of hazardous area across the Franks Tract makes it challenging to sustain an effective level of management.

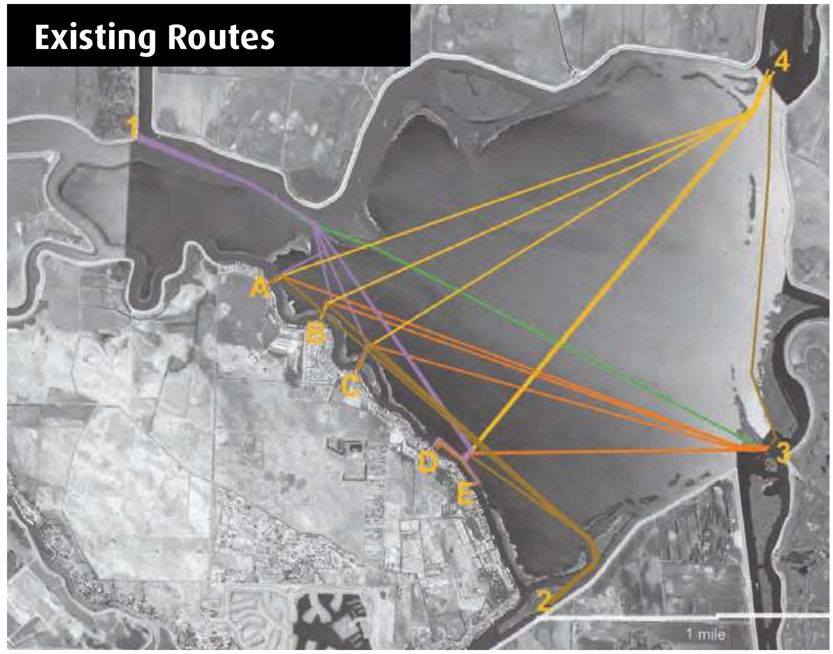
Boaters also enter and traverse Franks Tract through numerous levee breaks, where conditions can be dangerous. Boaters passing through these breaks often enter directly into waves that form across the vast open water of the Tract. Challenging boating conditions are

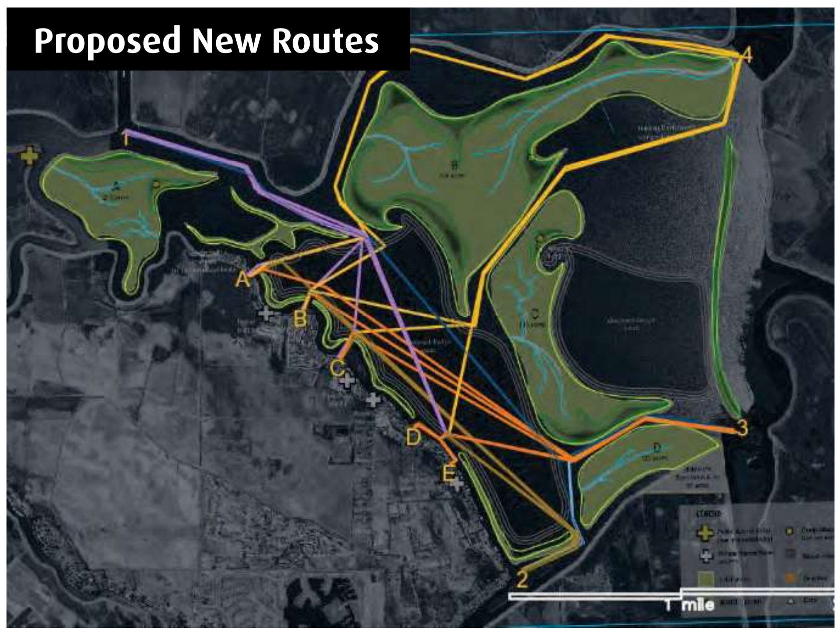

Photo: Brett Milligan

compounded at the southeastern corner of Franks Tract, where four navigation channels intersect in a location with limited visibility.

Objectives of the Franks Tract project include maintaining or improving the navigability of Franks Tract and minimizing potential conflicts between navigation and recreation.

The preferred design concept maintains open fast water channels, and easy access to multiple destinations. Other navigational benefits would be a reduction in existing hazards and nuisance conditions such as aquatic weeds and submerged hazards left over from flooding of the Tract, as well as a reduction of hazards at a variety of entry points to Franks Tract.





Boating Travel Distances

Fast water navigation routes between key locations are critical to local boaters and recreational users. Finding a way to allow for fast and safe boat navigation through Franks Tract while meeting the water quality objectives was a key planning concern.

Key locations for boat travel were determined with input from stakeholders and the public on Existing Routes map. Key navigation routes are:

- North Bethel Island to south Bethel Island (parallel to Piper Slough) (1 to 2)
- Bethel Island openings to southern corner of Franks Tract (Roosevelt Cut) (ABCDE to 2)
- Bethel Island openings to Holland Cut (ABCDE to 3)
- Bethel Island openings A, B, C, D, and E to NE corner of Franks Tract (ABCDE to 4)
- Bethel Island openings to Fisherman's Cut (ABCDE to1)
- Fisherman's Cut to Holland Cut (1 to 3)

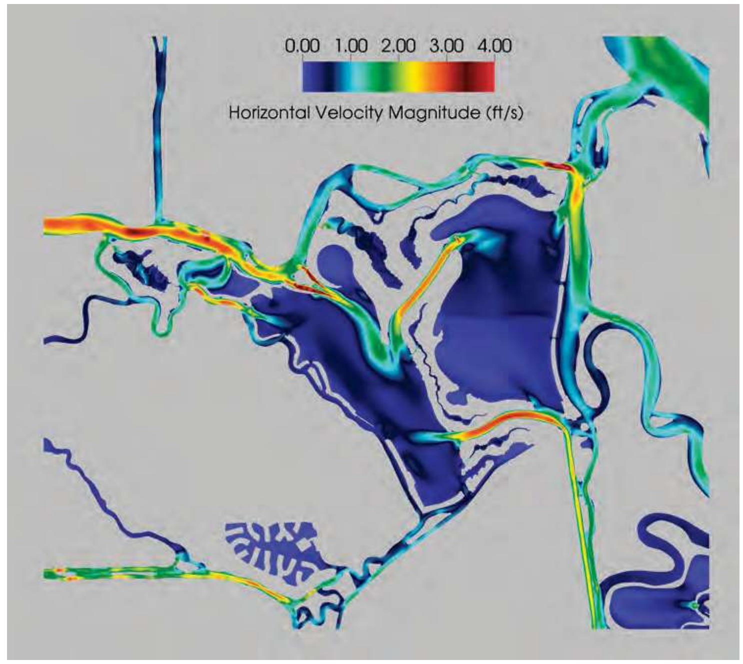
The planning team calculated the boating distance for each key navigation route under both existing conditions and the preferred design concept.

The preferred design concept maintains primary routes through the Tract with slight increases in travel distance. The preferred design concept maintains all boating routes as fast water without no wake zones. With these considerations, the preferred concept adds an average 8% increase in travel distances for key navigation routes, while improving the navigability of these routes through channel deepening and weed reduction.

Designing Channels for Fast Water Navigation

Different types of boats navigate and pass through Franks Tract, including motorboats, bass boats, ski boats, non-motorized kayaks and sail boats. These vessels can take any route, however most routes are compromised by snags, debris, or submerged vegetation. Creating tidal marsh landmasses, as proposed in the preferred design concept, will limit navigation to the through-channels between the landmasses. In designing for continued fast water navigation through these channels and the proposed marshes, the planning team made the channels as wide and deep as possible, while still meeting the project goal for water quality.

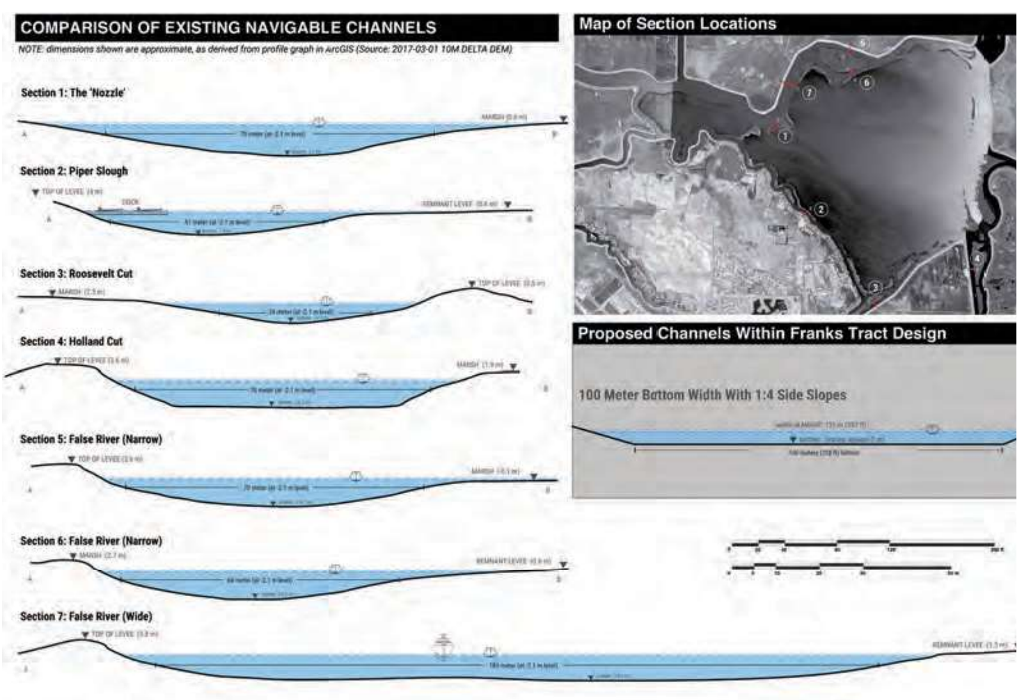
The preferred design concept includes through-channels 100 meters (330 feet) wide (similar in width to nearby Holland Cut) and 7-8 feet deep, sized to allow fast, two-way boat travel. The planning team modeled channel widths to confirm consistency with meeting the project goal for water quality (see below). The preferred concept also improves navigation by deepening channels, creating conditions unfavorable to the colonization of aquatic weeds, and removing hazards.



Modeled velocities at new entry points and intersections within a redesigned Franks Tract.

Boating Hazards

Boat entry into and out of Franks Tract can be somewhat hazardous from the east into Franks Tract, including from Old River on the northeast, Old River on the east, and Holland Cut on the southeast. Local stakeholders note that the long fetch and subsequent high waves at the eastern end create these hazardous conditions. In addition, the entry at the southeast corner of Old River/Holland Cut is especially hazardous due to impaired visibility at the intersection of five major channels. At another entry point, from False River on the northwest, high water velocities and existing levee remnants and snags create more hazards. As described above, submerged debris and snags, shallow water, and aquatic vegetation augment boating hazards throughout Franks Tract.



The preferred design concept calls for dredging to create landmasses and improve channels, which would remove many existing boating hazards. Dredging to create more extensive deeper areas on the Tract will reduce the potential for the shallow water weeds. The preferred concept includes other measures to improve boating safety such as removing existing underwater snags and hazards, sheltering the more wave-exposed eastern entrances to the Tract, and redesigning a safer entry from the southeast corner. Velocity models indicate that typical flows through the designed channels will be safe for motorized boating in all but rare extreme conditions, comparable to velocities in existing channels in the vicinity.

Minimizing Navigation and Recreational Use Conflicts

Maintaining navigation and improving recreation are both objectives of the Franks Tract Futures project. Water based recreation in Franks Tract takes diverse forms (see also next section). For example, bass boaters in a tournament may zoom from one side of the Tract to the other, searching out the best fishing spot, or aiming to get their catch in before deadlines. Kayakers may want to paddle slowly and watch birds, or sit in one place and fish. Larger motor craft may want to cruise up north to reach other recreation destinations. Meanwhile, visitors to any new beaches or shoreline amenities may want to launch kayaks or stand up paddleboards, or water ski. Allowing for all uses can be done within properly designed and sited areas that minimize placement of fast water channels adjacent to areas designed for other recreation activities. Nevertheless, if boat traffic is increased dramatically and holding capacity is exceeded due to increased recreation, conflicts may arise.

The preferred design concept sites recreation uses so as to minimize conflicts with fast water navigation. The planning team designed Little Franks Tract for non-motorized craft with no fast water navigation channels. They also placed mooring areas away from fast water navigation channels, and protected beaches from wind, waves and fast water.

RECREATION

Overview

Franks Tract supports a wide variety of recreation uses, including a world class bass fishery, waterfowl hunting, and various motorized and non-motorized boating activities. Before surrounding levees eroded, they provided boat-in access to fishing, walking, and nature viewing on their remnant shorelines.

Franks Tract also includes a State Recreation Area. Recreational use of the area is limited to boaters, anglers, and hunters. A General Plan for the area was prepared in 1988 (see Section 2, p.11) and has not been updated since that time. The 1988 plan identified a lack of a recreational land base, and thus its land use and development goals call for additional landforms, including the creation of beaches and vegetated upland areas for low intensity recreational use, while limiting the area to boat-in visitors.

Delta waterways have long been favored for recreation, primarily boating and water sports, along with fishing, hunting and day use picnicking and camping. These traditional activities and patterns of use should all be considered in planning for a future Franks Tract, however the design process opens up some new opportunities. New waterway and water body shapes, sizes and orientations could make the area more amenable to new types of recreation and safer and more pleasant for traditional activities.

A Franks Tract project objective is to enhance existing recreation uses, as much possible, while creating or expanding opportunities for new types of recreation.

The preferred design concept integrates diverse recreational improvements with consideration for, and benefits to, the local economy. The scale and diversity of these features has the potential to foster unique and regionally distinctive recreational experiences and a sense of place.

Fishing

Franks Tract currently supports a world-class bass fishery and many annual bass fishing tournaments (including striped bass, largemouth bass and other black basses). Other sportfish caught in Franks Tract include salmon, catfish, perch, and sunfish/panfish. There is no shoreline fishing activity within Franks Tract as there is no legal access to the shores.

Maintaining, improving, and creating recreation areas are companion goals to goals for tidal marsh restoration in the Franks Tract 2020 project. Restoring tidal wetland habitat will support native fisheries and improve recreational fishing.

The preferred design concept improves the recreational fishing experience at Franks Tract, primarily through enhanced sportfish habitat (see Ecology, p.54). Access to fishing from a boat at Franks Tract is presently through private marinas, predominantly on Bethel Island. In order to help maintain and enhance the local economy, no additional public boat launch points are planned on Bethel Island. The project plan does propose shoreline fishing access on Jersey Island, and perhaps Holland Tract along with non-motorized boat access. The project may increase conflict between anglers and other recreationists or boaters, depending on the popularity of proposed additional features in the project.

Motorized Boating

Water sports areas require a large open body of water somewhat sheltered from waves (with shorter fetch), ideally adjacent to beaches and mooring areas. The open water area should be large enough to allow for fast boats navigating across, water skiing/wakeboarding, as well as have quiet edges for fishing and non-motorized boating.

The Delta has a shortage of beaches, as well as places to simply get out of a boat and walk around.

Based on input from the Advisory Committee, a good beach should include sandy surfaces adjacent to active water sports pools and sheltered from winds coming from the west and northwest by landmasses and vegetation. A good beach should also be close to (but safe from) take-off and landing spots for water-skiers and wake-boarders.

Day use facilities should be large enough to accommodate multiple and various users, and include shade (either trees and/or shade structures), picnic tables, access to beaches, and perhaps a barbeque and coal disposal facility.

Mooring facilities should allow larger boats that cannot be directly beached to tie off and access beach and/or day use areas. Facilities should only be for larger boats (>20') and would allow for a reservation system for day or overnight. Mooring areas should be protected from wind and waves.

All of the above should also be situated whenever possible near restrooms.

The preferred design concept offers desirable water and sculpted landforms for recreation. It features two major open water areas perpendicular to the prevailing summer winds, providing shelter from wind and waves (see 1a and 1b on map). The project sites the widest pool on the eastern side, encouraging most of the water sports activity to locate in that area. The marsh islands between the two pools could accommodate land recreation activities with a desirable east facing orientation, sheltered from afternoon glare and wind. Marsh Islands would also provide opportunities for water-based recreation in and along their channels, such as birding, nature observation and seasonal hunting (discussed below).

The preferred concept would create two open water areas east (1A) and west (1B) of the central landmass, a sheltered water area in Little Franks Tract for non-motorized boating (2), a potential public access point on Jersey Island (3), four new beaches (4A, B, C, D) and improvements to Swing Beach, mooring areas (triangles), and several potential day use areas (circles).

The preferred design concept has three focal points for boat-to access to recreational activities that would attract three different user groups. The design pairs the eastern open water area with the active water sports enthusiasts; the Little Franks Tract with non-motorized boaters and paddlers; and the north end of the western open water area with those operating larger boats (see map above). The project proposes a cluster of facilities in each location to serve these users. All three have a beach and day use facilities and the two adjacent to the larger open water areas also have a protected area for boat mooring.

The preferred design concept also provides smaller boat-to sites, including four potential new beaches. Nearly all of the Delta shorelines and levees are privately-held and the most common request from the public and stakeholders is for shoreline destinations.

Non-motorized Boating

Boats without motors, including kayaks, stand up paddleboards, canoes, and sailboards, are increasingly popular. Many sports enthusiasts enjoy combining motorized boating with non-motorized boating (such as paddle boarding while moored) and non-motorized boating with nature viewing. Little Franks Tract was a destination for nature lovers in these kinds of boats until it became unnavigable.

The preferred design concept creates natural and restored wetlands that include destination areas with beaches, where people may want to pull small boats ashore to picnic, swim, or launch stand up paddleboards or kayaks. The design specifies Little Franks Tract as an area for non-motorized boating with a no-wake zone. The design includes a day-use and beach area oriented for non-motorized recreation, providing a focal point for access to restored tidal lands with slow channels for wildlife viewing.

Shoreline Recreation

As described above, Franks Tract has historically offered little access to the shoreline for hikes, picnics or shoreline fishing. Day use facilities and campsites would attract more visitors to Franks Tract and should be designed to accommodate multiple and various types of users.

The preferred design concept allows for shoreline recreation from Jersey Point and/or Holland Tract, but not from Bethel Island. This design protects the existing Bethel Island businesses who provide water access to the Tract. Any new shoreline facilities could include fishing piers, restrooms, picnic tables, wildlife viewing trails, shade structures, parking, and non-motorized boat access.

Hunting

Waterfowl hunters have historically visited Franks Tract for sport through a regulated system of permits for use of state hunting blinds, small structures that hide hunters from wildlife. Administering the permits for this unique system is one of State Park's primary management activities in the State Recreation Area. Management entails running the permit process for 54 hunting blind locations, as well as patrol and enforcement during the hunting season. Local hunters highly value the current hunting blind registration system and would like to see it maintained into the future.

The Franks Tract project would significantly change recreational hunting activity. Impacts to current shallow water hunting locations could be somewhat mitigated through the creation of marsh-based and free-roam hunting opportunities, as well as open water blinds in new deeper water areas and new upland habitats for breeding waterfowl.

The preferred design concept reduces the number of existing hunting blinds but improves upland habitat for breeding waterfowl and potentially creates new blinds in deeper water and opportunities for marsh-based hunting. The preferred concept assumes the loss of between 29 (62%) and 36 (77%) of existing open water blind locations, depending on the viability of deeper water blinds. Blinds could potentially be installed in the new deeper water areas but would require different techniques for securing them (such as floating blinds and/or the use of a buoy system). The deeper open water areas created by dredging will attract different waterfowl (diving ducks) than shallow water areas (dabbling ducks).

Approximately 50 new marsh-based hunting blinds could be created around constructed ponds and along the new marsh channels. As designed, the result would be a net gain of between 14 and 21 blinds above the current 54 maximum permits. Alternatively, a lesser number of fixed blinds could be permitted within the new marshes to allow for free range hunting opportunities. Free range hunting enables hunters who might not have the resources to own or create blinds to hunt, as well as allowing for movement and creativity in hunting techniques not afforded by blinds.

Interviews with hunters suggest that many will be interested in taking advantage of new marsh-based hunting opportunities, but current hunters would face a change and reduction in conditions they value. By maximizing the number of open water blinds (by adjusting the current grid to optimize for the new configuration of the Tract) the preferred design can retain hunting capacity in the area.

Strategically placed upland areas, adjacent to brood ponds, could support more local waterfowl breeding (further consultation will be required to inform the design of upland-pond complexes to optimize breeding potential).

The preferred project encourages continued hunter stakeholder input in the development of any new hunting opportunities and protocols. Stewardship opportunities - such as hunter management of hunting ponds – could provide mutual gain among agencies, hunters and members of the general public.

LOCAL ECONOMY

Photo: Brett Milligan

Overview

An economic assessment conducted for the Franks Tract 2020 project explored current conditions and potential impacts on the local economy, which revolves around Bethel Island. Bethel Island businesses benefit from proximity to visitors from the urbanized Bay Area but the island is not a traditional business location. Indeed, the economic wellbeing of Bethel Island is reliant on the popularity of outdoor recreation in the central Delta, particularly boating and fishing. Jobs data show that approximately half of the employment on Bethel Island is directly tied to recreation. Accommodation and food service are the most significant employers (pre Covid-19). Despite the Bay Area's strong recovery from the 2008-9 recession, the local Bethel Island economy supports roughly 15 percent fewer jobs than it did about 15 years ago.

While the local economy has contracted, some local businesses on Bethel Island are thriving today. A number of marinas reported successful business models that focus on unique customer groups. The popularity of largemouth bass fishing tournaments has also been a boon for Bethel Island. While participation in fishing is waning nationally and in California, largemouth bass fishing has continued to grow in popularity. With various Delta tournaments occurring weekly during fishing season, Franks Tract has been and could continue to be a central hub for this economic activity.

The Franks Tract project planning team reviewed all available economic data and also conducted in-person and telephone interviews with business owners, association members, recreation guides and participants, and residents to better understand how the project could affect the local economy, with a focus on Bethel Island. Interviews explored whether the proposed recreation and restoration plan could be good or bad for business, increasing or decreasing customer volume, spending, or other business factors (pre-Covid).

Overall, the key objectives of Franks Tract project are in line with local business goals and economic development. The project seeks to improve water quality, restore native ecology, and enhance recreation. And with the Bethel Island economy tied to the quality of local environmental conditions and recreational opportunities, specifically factors that influence boating and fishing, the proposed project is expected to sustain and grow local economic opportunity. The economic analysis is provided in Appendix C.

Improved Navigation & Safety

The current and ongoing degradation of environmental conditions in Franks Tract is a business risk, with invasive aquatic weeds generating the most concern. Likewise, conditions in some fast-water channels and intersections can be treacherous, while submerged snags and thick weeds continue to pose navigational hazards. Recent trends in environmental quality at Franks Tract and the Delta have been detrimental to recreation. While the state has taken actions to reduce invasive plants in the Delta, such as spraying herbicides, locals worry that control measures may harm fish populations and fishing.

For local businesses, if the boating and fishing conditions are first-rate, and navigation and access are sustained or improved, the prospects for ongoing local business success are strongest.

The preferred concept will benefit the local economy by improving environmental conditions and navigational safety (see Navigation p.44). The possibility that the water depths achieved by the Franks Tract project could reduce invasive weeds is seen as a positive for recreation and related businesses.

Environmental Quality

Water quality in Franks Tract is of significant concern to local business. The continued spread of aquatic weeds and increasing herbicide use are often cited as worrisome. Warmer water and continued weed growth can also result in harmful algal blooms, odors, and fish kills that aren't good for boating- and fishing-based businesses. Business owners also mentioned increasing intrusion of salt water as a concern.

The preferred design concept would improve water quality by dredging and deepening areas plagued by aquatic weeds. The project could also reduce herbicide use depending on management. The project avoids creating areas of poor circulation that would be prone to harmful algal blooms and associated problems. The project acts to block salinity intrusion with new land masses, though the small changes in salinity associated with the project are meaningful only in terms of water quality for human use. Even with nearly two feet of sea-level rise (see Water Quality p.55), salinities are still generally considered "fresh water" in terms of effects on environmental and recreational uses. The project, however, might reduce the need for emergency drought barriers disruptive to the local and state economy.

Access, Amenities & Leisure

Easy access to Bethel Island across Franks Tract is essential to the local economy. Bethel Island's historical success as a recreation economy is largely due to its central location within the Delta and convenient access to major waterways. For boaters driving in from the Bay Area, it is among the best launch locations for trips into the heart of the Delta.

The Bethel Island business community acknowledges that the Delta remains somewhat undiscovered and that the natural beauty and recreational opportunities are not well marketed. While there is some concern that increased consumer awareness of Franks Tract and economic growth could erode the tightknit community and the rustic character that makes Bethel Island so special, locals seem to agree that the economy will benefit from investment, along with marketing and branding to leverage that investment.

For boating in particular, the project introduces significant opportunities for improvement, by increasing access and re-establishing Franks Tract as a compelling destination recreation area within the Delta. Boaters, including power boaters, sailors, and paddlers, seek outings that are structured around a place to go, and the Franks Tract project could become a must-visit point of interest.

The preferred design concept increases the attractiveness and draw of Franks Tract for leisure activity, and businesses likely will benefit from new visitors (see Recreation p.43). The concept includes significant enhancements to the existing State Recreation Area. The recreation components of the preferred design include new day use areas with picnic areas and restrooms, overnight camping, mooring fields for day and overnight use, docks, beaches, and enhanced public access. These recreational improvements, in combination with successful environmental restoration and improved navigation, have the potential to increase visitation and economic activity on Bethel Island.

Competition

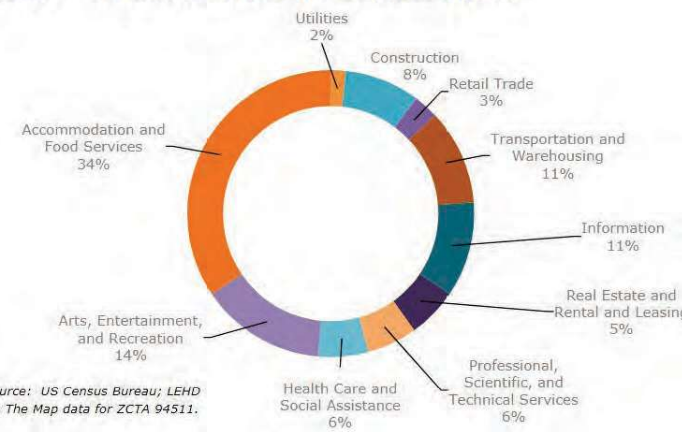
Locals are concerned that new recreational amenities will compete with local business. The most frequently voiced concern was the possibility of public boating access on Bethel Island, be it non-motorized or motorized. Stakeholders expressed similar concerns about motorized boating access on North Holland Tract at a parks facility, but were not concerned about potential non-motorized boating access at that location. The launch business is an important source of revenue for Bethel Island businesses.

The preferred design concept does not include a public boat launch on Bethel Island.It does propose a potential new non-motorized boat launch facility that would improve accessibility to Franks Tract's expanded recreational amenities. Details of this facility would need to be explored in future planning phases.

Real Estate Values

Economic research reveals that real estate with scenic or water views, nearby open spaces, and recreational opportunities achieves a price premium in the market. Residential and commercial properties on the northeast shore of Bethel Island enjoy expansive views of Franks Tract. Vegetation at the edge of Piper Slough interrupts the view slightly, but beyond that, one can see the vast waterbody and distant horizon.

Figure 5 The Bethel Island Economy—Jobs by Industry (2017)



Source: US Census Bureau; LEHD On The Map data for ZCTA 94511.

Local experts confirm that boat access to fast water and scenic views of open water are key determinants of residential real estate value on Bethel Island. Accordingly, home prices on the northeast side of Bethel Island enjoy a premium over other locations. While the west side of the Island has sunset views, Taylor Slough is weedy and westward horizon views are partially obstructed by utility lines, which undermine values.

The preferred concept locates new landmasses away from the Bethel shoreline, protecting property values derived from open water views. Despite some potential for viewshed impacts, if boating navigation improves dramatically as a result of the project, that could have a positive, offsetting effect on property values. Property values may also increase with new amenities and wildlife habitats in their vicinity.

Construction & Maintenance

Construction and maintenance of the Franks Tract project could bring new jobs to the area, and support local restaurants, services, and businesses in Bethel Island.

The preferred concept, as a design proposal, does not yet implement operations and maintenance of the Franks Tract Futures project. If the project is developed successfully but poorly managed, there could be negative impacts. If the project is well-run and maintained to high standard, with sufficient safety services, public information, and capacity control, the benefits to the local economy could be significant.

Any construction team would need to address concerns about one time impacts such as inhibited business activity, disturbed fisheries, displaced bird populations, compromised navigation, and other issues during the construction period. Strategies to minimize recreation and business impacts from construction would be implemented extent practicable (see Section 7).

Collective Benefit

Businesses on Bethel Island are working together to advocate for Franks Tract and the Delta. There is a realization among business owners that collective action is needed to avoid further deterioration of environmental quality and the local economy. Significant public investment in Franks Tract is perceived to be beneficial to the community broadly. Many of the perceived local economic benefits are derived from improved recreational opportunities, without which the project would lose support from local business owners, residents, and longtime recreational users.

The preferred concept does not create disproportionate impacts on any particular business type or location on Bethel Island. The well-distributed potential benefits of the Franks Tract project support continued business collaboration. Cohesion within the business community on Bethel Island is a positive attribute of the local economic fabric that may be leveraged to increase benefits from the Franks Tract project. The planning team recognizes that the combined depth of knowledge in the business community offers an invaluable resource for any future project development and implementation.

ECOLOGY

Photo: Rick Lewis

Before humans reclaimed vast marshy flats in the Delta to convert them to farmland and build towns, the region featured a complex network of rivers, sloughs, and tidal wetlands. The historical landscape supported native estuarine fish like Delta smelt and juvenile Chinook salmon, providing food, shelter, and migratory corridors along the marsh channels and through adjacent open water areas.

Today, the Delta's aquatic landscape is a highly altered system of levees and channels. In addition to native species, it now a supports a prized sport fishery. Approximately 97% of the historic tidal marsh has been lost (SFEI 2016). Small remnant islands of tidal marsh within False River and some of the surrounding channels are all that remain.

Characteristics of a healthy Delta ecosystem, according to the Delta Reform Act, include diverse and biologically appropriate habitats and ecosystem processes, functional corridors for migratory species, and viable populations of native species (California Water Code section 85302[c]).

Objectives of the project include establishing large areas of tidal marsh habitat for fish species of interest.

The preferred design concept would restore lost tidal marsh habitat to benefit a range of species, maintain or enhance habitat for native and recreationally important fish species, and discourage nuisance, invasive aquatic weeds.

Tidal marsh

Tidal marsh is important habitat for both aquatic and terrestrial species. Freshwater emergent vegetation grows in the marshes of this part of the Delta, predominantly consisting of tules (*Schoenoplectus spp.*), bulrushes (*Bolboschoenus spp.*), and cattails (*Typha spp.*). In the adjacent shallows, primary production processes produce dissolved organic matter, phytoplankton, zooplankton (e.g. copepods, cladocerans, mysid shrimp), insects, and detritus. Increasing this primary production, by reintroducing tidal action to Delta landscapes, supports the aquatic food web (Sherman et al. 2017). Native fish, waterfowl, and diverse local wildlife all benefit from the inputs of primary producers in tidal marsh.

The preferred design concept proposes to create approximately 1,370 acres of new tidal marsh, including vegetated (emergent) tidal marsh plain and tidal channels, with smaller areas of adjacent upland habitat. Tidal channels will consist of multiple dendritic dead-end channels ranging in sizes, similar to channels of the historic Delta marshes. Channels will be largest (deepest and widest) where they enter the marsh (e.g., adjacent to False River), and smallest at their termini inside the marsh.

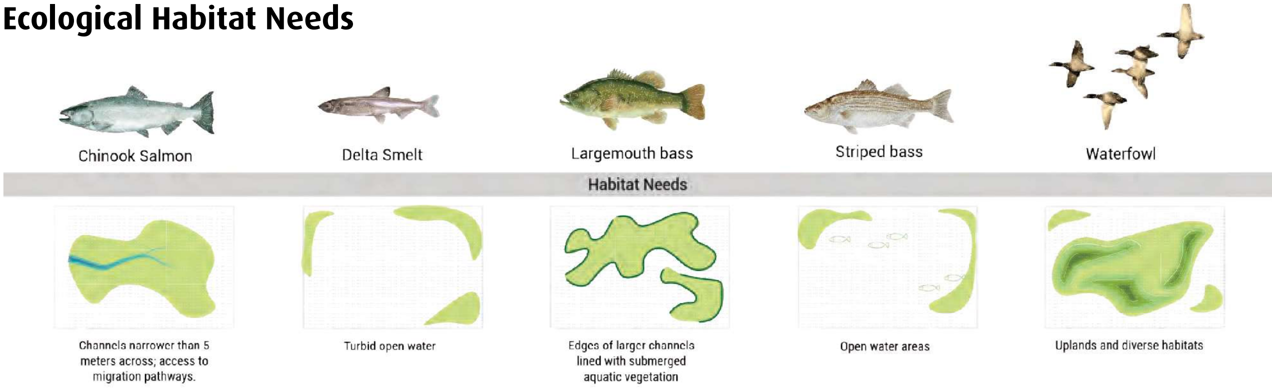
The marsh plain would be integrated with new riparian areas created along higher ground at the edges of major tidal channels to promote habitat diversity. Riparian habitat would consist of cottonwoods (*Populus fremontii*), arroyo willow (*Salix lasiolepis*), black willow (*Salix gooddingii*), box elder (*Acer negundo*), or other native Delta trees and shrubs. Though project planners have not yet developed a revegetation plan, the objective would be to reestablish native tidal marsh and riparian vegetation relying on a combination of natural vegetation colonization processes and planting of native plants. Some level of planting of native plants would be required to minimize the colonization of invasive weeds that may invade suitable unvegetated areas. Any revegetation effort would include a planting design detailing the types and locations of native plant species. The additional acreage and diversity of tidal marsh habitat planned for Franks Tract under this preferred concept would benefit both aquatic and terrestrial organisms.

Habitat for Special Status Native Fish

As noted in the prior section, the shallow-water habitats with dendritic channels and emergent wetland vegetation present in the Delta historically provided refuge and food resources for many native fish species. Current conditions represent a heavily altered ecosystem with reduced habitat and increased abundance of invasive plants and nonnative predatory fish, low food productivity, and continued risk of fish entrainment into the south Delta region (Baxter et al. 2008, Grimaldo et al. 2009). These conditions have led to a less favorable habitat for native species.

The proposed habitat enhancements for Franks Tract focus on two special-status fish species: Delta smelt (*Hypomesus transpacificus*) and Chinook salmon (*Oncorhynchus tshawytscha*). In addition to creating new tidal marsh habitat and associated food web support, planners designed the preferred concept to alter the hydrodynamics of Franks Tract to reduce regional south Delta reverse flow effects. This

Ecological Habitat Needs



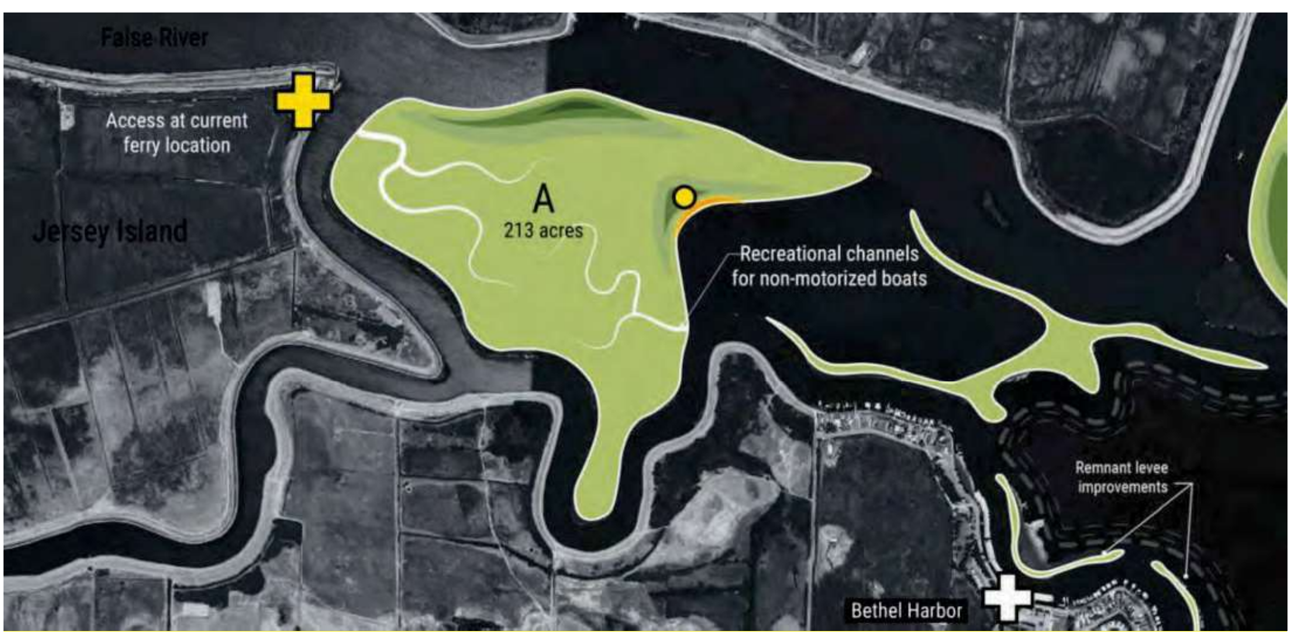
change would reduce the associated risk of special-status fish species entrainment towards the state and federal water projects (pumping facilities) in the south Delta.

Delta smelt is a small fish, endemic to the San Francisco Estuary in California with a typical life cycle of one year, although some adults may live to a second year. Juvenile and adult Delta smelt are a euryhaline species (tolerant of a wide salinity range) that inhabit freshwater portions of the Delta and extend into low salinity portions of Suisun Bay. Adult smelt migrate upstream from the brackish water habitat of the low salinity mixing zone to spawn in freshwater areas. These spawning areas are primarily in the north Delta, but also include Franks Tract, beginning in December to July and August (Sommer and Mejia, 2013). After the eggs hatch, river flows and tides distribute larval smelt downstream into low-salinity habitats of the central Delta where they continue to rear through summer and fall (Moyle, 2002).

Once abundant throughout the Delta, a variety of environmental factors have led to the decline of Delta smelt, including changes in species composition and abundance of zooplankton prey species, increased potential for entrainment into south Delta water diversions, and increased predation by other fish species. Today, Delta smelt are rarely detected in state and federal sampling programs. The decline of the species has led to special-status species listings as endangered under the California Endangered Species Act (CESA) and threatened under the Federal Endangered Species Act (FESA).

Critical habitat was designated for Delta smelt in 1994 and became effective on 18 January 1995. Critical habitat is designated as Suisun Bay and Marsh and the existing contiguous waters contained within the Delta (including Franks Tract), as defined in Section 12220 of the California Water Code.

Creation of Tidal Marsh & Native Fish Habitat at Little Franks Tract



The preferred design concept restores Delta smelt habitat, consistent with goals of the 2016 Delta Smelt Resiliency Strategy and actions outlined in the U.S. Fish and Wildlife Service's 2008 Delta Smelt Biological Opinion, which requires the restoration of 8,000 acres of tidal marsh habitat. The restoration creates 113 acres of tidal marsh habitat in Little Franks Tract and additional tidal marsh in Franks Tract.

Within the tidal marsh landmass in Little Franks Tract, the design incorporates dendritic, tidal marsh channels with connectivity to Piper Slough, False River, and open water habitat in Little Franks Tract. The western portion of Franks Tract, including Little Franks Tract, is expected to offer the best restoration opportunity for improving Delta smelt habitat because it is farthest westward and closest to areas of the estuary that experience fluctuations in salinity. It is also largely separate from areas enhanced for recreationally important nonnative predator fish habitat in Franks Tract.

Riparian willow.

Chinook salmon are an anadromous fish species, spawning in freshwater and spending a portion of their life cycle in the ocean. Chinook salmon spawn upstream of the Delta in cool, clean, and well-oxygenated waters that contain adequately sized spawning gravel, instream cover, and riparian shade. Chinook salmon use the Delta, including Franks Tract, during adult upstream migration, smolt emigration, and juvenile rearing (Moyle, 2002). There are four runs of Chinook salmon within California's Central Valley that vary in migration timing and reproduction behavior, two of which are state and federally listed.

Sacramento River Winter-Run Chinook salmon are listed as endangered and Central Valley Spring-Run Chinook salmon are listed as threatened under FESA and CESA. Designated critical habitat also includes portions of Franks Tract for both special-status Chinook salmon runs. Additionally, essential fish habitat as required by the Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 USC 1801 et seq.) has been designated for all four runs of Chinook salmon. Essential fish habitat includes migration, holding, and rearing habitat in the Delta, including Franks Tract, Sacramento River, and major tributaries.

The preferred design concept would create 760 acres of tidal marsh habitat along the northern part of Franks Tract. Planners placed this northern landmass adjacent to False River with the objective of creating a protected, migratory corridor for Chinook salmon along the northern extent of the Tract. The design provides narrow, tidal marsh channels suitable as refuge and rearing habitat for outmigrating juvenile salmon. It also connects tidal channels and the marsh plain to adjacent open water, potentially increasing marsh-derived primary productivity.

Habitat for Recreationally Important Fish

People come from all around the world to fish Franks Tract for largemouth bass and striped bass. As mentioned in earlier sections on recreation and the local economy the Tract hosts numerous tournaments each year. Restoration designs for Franks Tract aim to not only improve habitat for native fish such as Delta smelt and Chinook salmon, but also maintain habitat for species important to the sport fishery.

Largemouth bass were introduced to California in the late 1800s for their sport fishing appeal. Since their introduction, largemouth bass have expanded their distribution throughout the state and are now abundant everywhere in the Delta. This warm, freshwater species prefers salinities less than three parts per thousand and shallow (generally less than 20 feet deep) open water habitats with little water current (Moyle 2002). This species also favors relatively dense areas of submerged aquatic vegetation, which Franks Tract currently offers (Conrad et al., 2016; Young et al., 2018).

The preferred design concept creates increased areas of shallow, edge habitat along tidal marsh land masses with depths less than 20 feet. Some portion of these shallow, edge habitats will likely be colonized with submerged aquatic vegetation. These edge habitats and vegetation provide largemouth bass with potential spawning habitat and foraging habitat for juveniles. Submerged vegetation supports a variety of aquatic macroinvertebrates (e.g. amphipods) which are an important component in largemouth bass diets (Weinersmith et al. 2019). Anticipated water quality improvements are not likely to substantially influence the presence or health of bass species.

Striped bass is another popular species among anglers within Franks Tract and the Delta. Introduced to the California in 1879, striped bass are now abundant throughout today's altered Delta ecosystem. Juveniles feed along channel edges while adults occupy open water, pelagic habitat. Striped bass are naturally anadromous, regularly moving between marine and freshwater environments, and spending most of their lives in estuarine conditions. Key habitat elements for striped bass include large, cool river environments with enough flow to distribute suspended larvae into the estuary, an open body of water with abundant prey fish, and protected areas for juveniles to grow by feeding on invertebrates (Moyle 2002). Velocity gradients, where there is a change in water velocity into an open water area, were expressed as desirable by the local fishing community. Such velocity gradients occur at several existing confined open water connection points between False River and Franks Tract.

The preferred design concept creates several locations with velocity gradients that are expected to be favorable for striped bass (see p.46). One location is in the north of the Tract, where velocity gradients are maintained at existing connection points. The preferred concept creates additional velocity gradient locations on either side of the central landmass and along the breaks in the eastern most enhanced levee. Planners predict that additional velocity gradients would attract striped bass similar to the existing connection points. The design also includes dredging and deepening of the open water areas expected to support striped bass.

Invasive Aquatic Vegetation

Invasive aquatic vegetation grows both on the surface (floating) and underwater (submerged) in channels and shallow waters throughout the Delta. In addition to being a boating hazard, invasive submerged and floating vegetation are ecologically undesirable for native fish species and can exacerbate algae blooms and other water quality problems by reducing circulation.

Submerged aquatic vegetation (SAV) typically consists of rooted vascular plants within slow-moving or still waters. The depth in which SAV can persist is primarily dependent on how deep sunlight penetrates into the water. The shallow depths of Franks Tract allow for SAV colonization, resulting in dense stands throughout the interior of the Tract. SAV in Franks Tract is dominated by the invasive species Brazilian waterweed (*Egeria densa*), Eurasion watermilfoil (*Myriophyllum spicatum*), water primrose (*Ludwigia spp.*), and coontail (*Ceratophyllum demersum*).

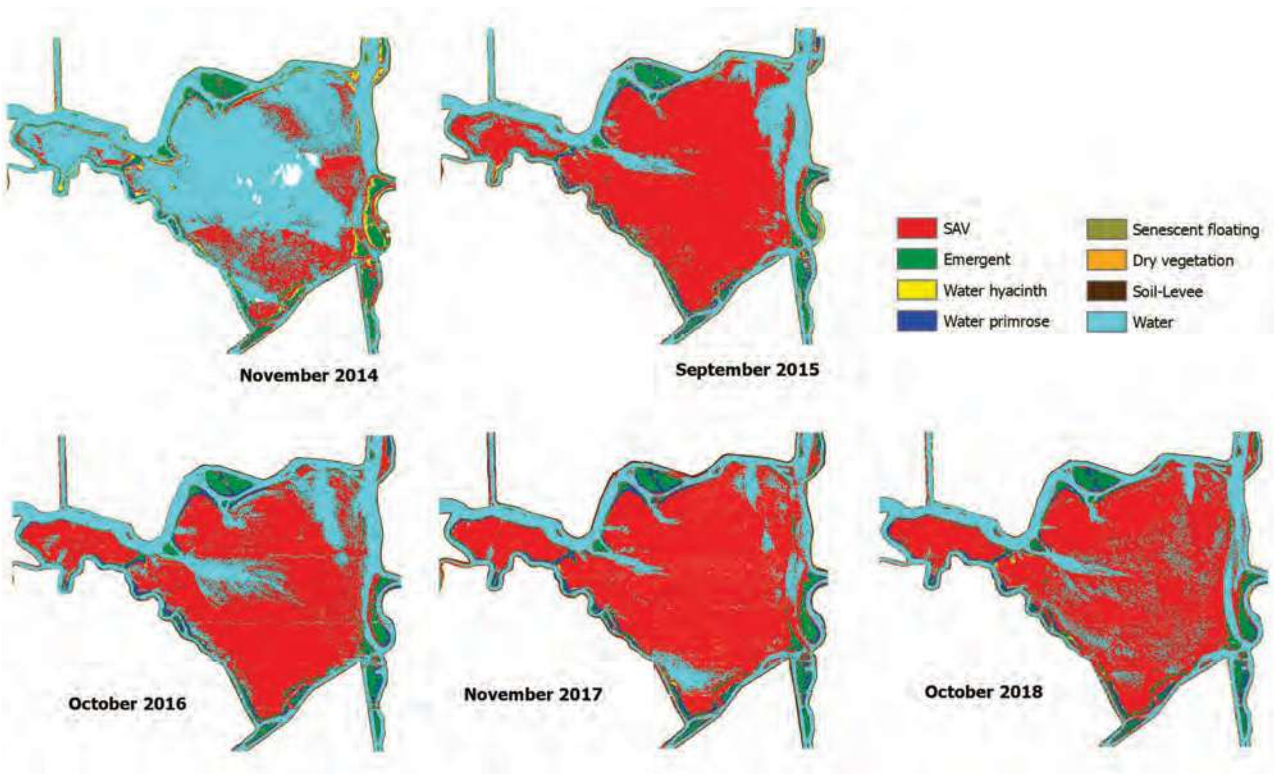
Floating aquatic vegetation (FAV) is non-rooted, free floating plants at the water's surface or within the water column. Wind, currents, and tides can circulate and redistribute these floating mats of vegetation. Within Franks Tract, water hyacinth (*Eichhornia crassipes*) is the most common species of invasive FAV. Dense mats of water hyacinth are especially a nuisance, restricting navigation, presenting boating safety hazards, and clogging waterways and marinas.

Submerged and floating aquatic vegetation covers a large portion of Franks Tract. Research by the Center for Spatial Technologies and Remote Sensing at the University of California, Davis shows trends of increasing densities of aquatic vegetation within the central Delta including Franks Tract (Ustin et al. 2017)

The preferred design concept could reduce the establishment of SAV and FAV in some areas of the project. Creating tidal marsh landmasses, for example, would reduce the total area of open water available for colonization by these aquatic weeds. Deepening portions of the remaining open water would also discourage establishment of rooted SAV.

While the preferred concept seeks to reduce the establishment of invasive aquatic vegetation, some level of continued management is expected to be necessary. The Department of Boating Waterways has been managing aquatic vegetation since 2006. Land use changes embodied in the preferred concept may allow the department to more effectively manage the site for weed control within their existing level of funding, potentially resulting in fewer nuisance weeds. If restoration were to occur, funding for weed management would need to continue.

Infrared Mapping of Submerged Aquatic Vegetation in Franks Tract



Source: Ustin S. L., Khanna S., Lay M., and Shapiro K., 2019.

WATER QUALITY

Overview

Franks Tract plays a central role in the exchange of salt, food, sediment and biota between the west, central, and south Delta. The geometry of Franks Tract contributes to a mixing phenomenon called tidal pumping, a mechanism that traps and disperses saline water and fish from False River into Franks Tract and on to the south Delta (see below).

The Franks Tract region is also a nexus of regulatory control. State Water Quality Control Board Decision D-1641 prescribes water quality standards for agriculture and water exports at locations throughout the Delta, but standards at sites in the vicinity of Franks Tract are frequently the ones that limit the amount of fresh water the state and federal water projects can divert. As sea levels rise, the water cost (associated with upstream reservoir releases) of compliance with Delta standards is expected to increase.

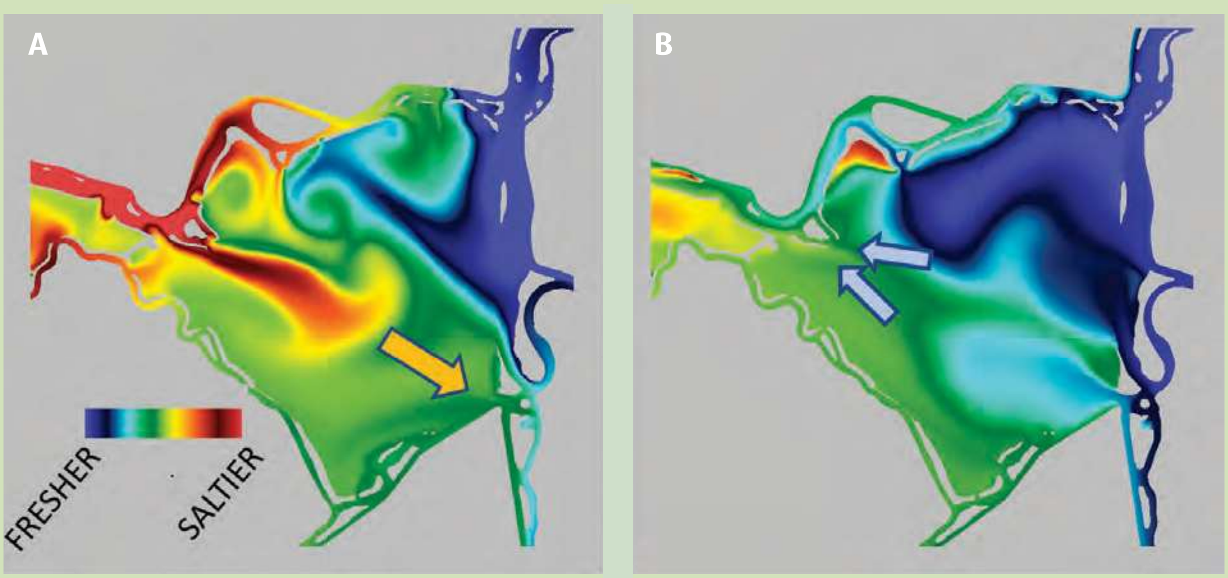
Water quality problems and difficulty meeting standards can increase with drought. Additional management measures are sometimes required to protect the fresh water corridor from salinity intrusion. In 2015, an emergency drought barrier was constructed in west False River to limit salinity transport into Franks Tract and subsequently into the central Delta. The barrier minimized salinity intrusion but was costly. It also negatively affected navigation and recreational uses of the Delta, especially in the vicinity of Franks Tract (see also p.14).

In addition to trapping and transporting salt, tidal pumping at Franks Tract can also entrain state or federally protected fish species towards the south Delta pumping facilities where chances of survival are reduced (see prior section). Presence or salvage of

Why is Franks Tract so Important to Salinity Intrusion?

Franks Tract is important to salinity transport through a mechanism called tidal pumping. Tidal pumping is a phenomenon that occurs when small inlets constrict flow entering an open water body. The figure below uses snapshots from a model simulation to illustrate this phenomenon as it occurs within the current geometry of Franks Tract. In Panel (a) a strong and narrow jet of higher salinity (red) water can be seen entering Franks Tract from False River on a flood tide through an aperture sometimes referred to as "The Nozzle." Salinity in this jet is most influenced by the San Joaquin River at Jersey Point, which in summer is higher than that of Franks Tract. Panel (b) shows the return flow from Franks Tract. It is fresher (blue and green) because the salty jet of water will have mixed with ambient water in Franks Tract and ebb flow draws from a broader area of more diluted water. Even if the volume of flow is the same in both directions, the asymmetry between a salty flood and a fresher ebb adds up and causes a net transport of salt into the central Delta.

Tidal Pumping



protected species at the south Delta pumping facilities can trigger Old and Middle River reverse flow restrictions and curtail pumping. Fish entrainment is thus both a water supply reliability consideration, as well as an ecological consideration for Franks Tract design concepts.

Objectives of the Franks Tract project include improving water quality and supply reliability.

The preferred design concept reduces trapping and transport of salts through Franks Tract, based on hydrodynamic modeling. The project improves water quality in the central Delta and reduces fish entrainment potential from the west. The project could also reduce water release from reservoirs that would otherwise be necessary to improve water quality in the central Delta. The project provides significant drought protection as well, reducing the frequency with which a salinity barrier may be needed.

As noted, the Franks Tracts futures project has no influence over water project operations, Delta exports, or proposals for alternative conveyance.

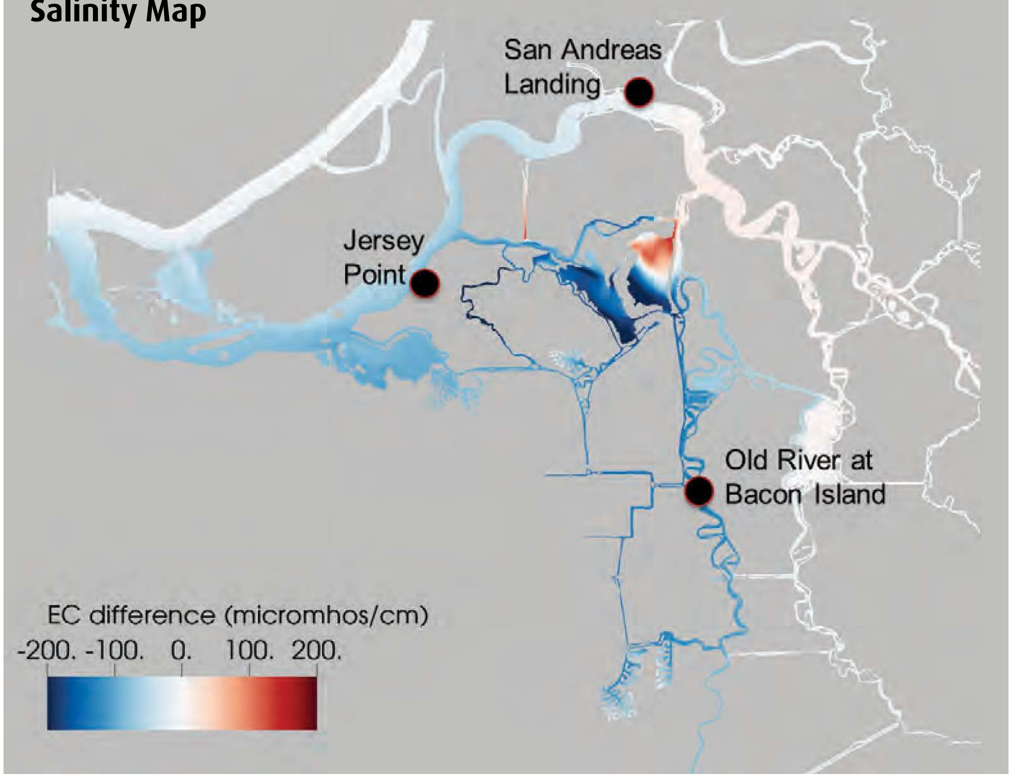
Salinity Control

Salinity intrusion from the Bay usually reaches the western Delta in late summer or fall depending on Delta outflow conditions. Under these conditions, water quality negatively affects beneficial uses of the State's waters (for human uses, agriculture, fish and wildlife habitat, etc.) and plays a controlling role in water project management. Water quality standard locations include the San Joaquin River at Jersey Point and Old River at Bacon Island near Rock Slough where the Contra Costa Water District maintains an intake.

The preferred design, as modeled, would improve regional water quality (salinity) conditions.

The salinity map shown below, is a change map from the Bay-Delta SCHISM model (see Appendix D) that illustrates the projected spatial distribution of salinity difference (Preferred Concept minus No Action alternative) averaged over August 1-14, 2009 using historical hydrology. The year is categorized as Dry. Results are expressed in units of electrical conductivity (or μS/cm, as saltier water conducts electricity better than fresh and conductance is often used as a surrogate measurement for salinity). Areas shown in blue are fresher — reductions in salinity occur around Franks Tract particularly upstream on the Old River system. Few areas are degraded significantly (i.e., by more than 10-20μS/cm).

Salinity Map



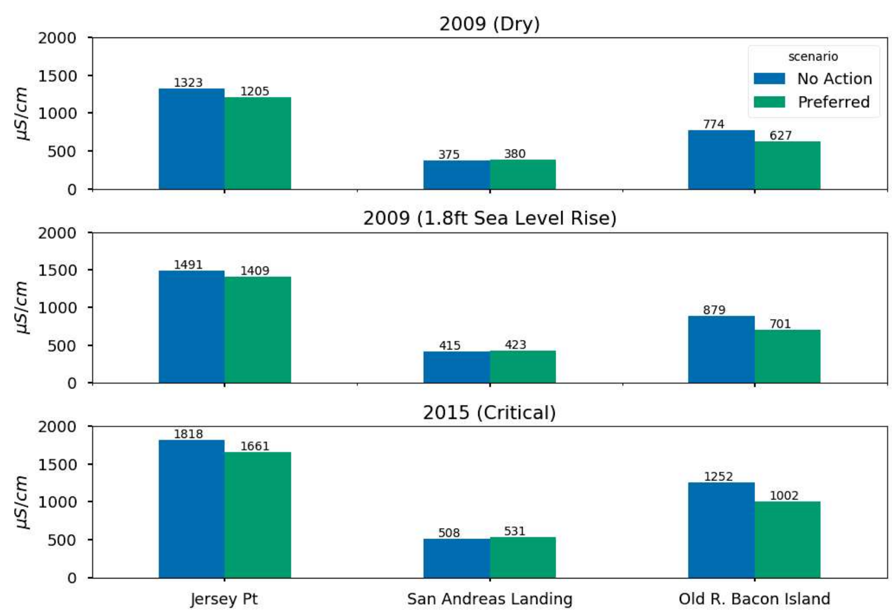
The salinity bar chart, opposite, compares model salinity changes at three locations used as indicators for the structured decision making process (see Section 4, p.25). Several hydrologic scenarios are shown – the 2009 dry year historical hydrology was used as the basis for general salinity assessment and design comparisons. Results are averaged between August 1 and November 30, 2009, a large fraction of the season when salinity is a compliance issue in the region. Some site-specific notes are as follows:

Old River at Bacon Island: The station on Old River at Bacon Island was used as the primary station to determine the effectiveness of the project. It is representative of the region of greatest benefit upstream (south) of Franks Tract, and is also proximate to Rock Slough, a D-1641 compliance point. Old River concentrations are also a predictor of ocean salinity effects farther south near the state and federal water projects. The persistent 150-200μS/cm freshening at this location represents an improvement compared to No Action as great as 20-25 percent.

Jersey Point: Jersey Point, also a D-1641 station, is located on the San Joaquin River downstream of Franks Tract where an agricultural water quality objective often governs water management through August 15. Jersey Point is more indirectly affected by changes in dispersion and tidal energetics in Franks Tract, and it was not known before changes were modeled that this location would be freshened. The projected salinity improvement at Jersey Point is modest in relative terms but nevertheless an important finding because it implies there is no tradeoff between downstream and upstream objectives.

San Andreas Landing: San Andreas Landing is a D-1641 compliance station, but one that has rarely been a compliance limiter under historical conditions. It was included as a precautionary measure — model-

Salinity Bar Chart



Potential Water Project Operations Response to Franks Tract Project

As noted above, the project does not influence water project operations directly. However, the Advisory Committee has requested that the planning team qualitatively consider how water operations may evolve in response to the proposed Franks Tract project and whether there would be any effect on project benefits. In particular, there is interest in how the project would perform with potential Delta Conveyance Project (tunnel) operations to the extent that these operations have been defined.

Any operational adjustment to the Franks Tract project would vary by season, hydrology, water demand and the myriad other factors that influence water project operations. The planning team considered various seasonal and flow scenarios (see Modeling Appendix; in progress) and concluded that changes in water project operations in response to the project are unlikely to significantly offset water quality benefits in the central Delta for most seasons across a range of wet and dry hydrologies. The exception is from August 15 though the fall in drier years, when the project would make maintaining the required salinity in the central Delta achievable with less outflow. Operators could reduce upstream reservoir releases or increase diversions at Clifton Court, keeping Central Delta water quality closer to without project levels. Standards and agreements upstream and downstream of the Franks Tract enhancement project would determine the extent and feasibility of this type of change.

The Delta Conveyance Project (tunnels) introduces effects that are largely independent of the operational changes sketched above. The tunnels do not alter the Delta outflow required to meet managerial requirements nor do they free the agencies from their obligations to do so. The scenario in which Franks Tract and any Delta Conveyance project would most likely have to be considered together is the fall post-August scenario described above. If the tunnels were in place, operators might implement reduced outflow by diverting flow at the tunnel intakes rather than reducing upstream reservoir releases or increasing exports in the south Delta which are the current options.

The water quality study conducted for this project provides qualitative consideration of operational adaptations. Quantifying operational responses more specifically would require more detailed assessment and use of a statewide water operations planning model. The modeling done for this Franks Tract enhancement project is a prerequisite for such an effort and further planning phases.

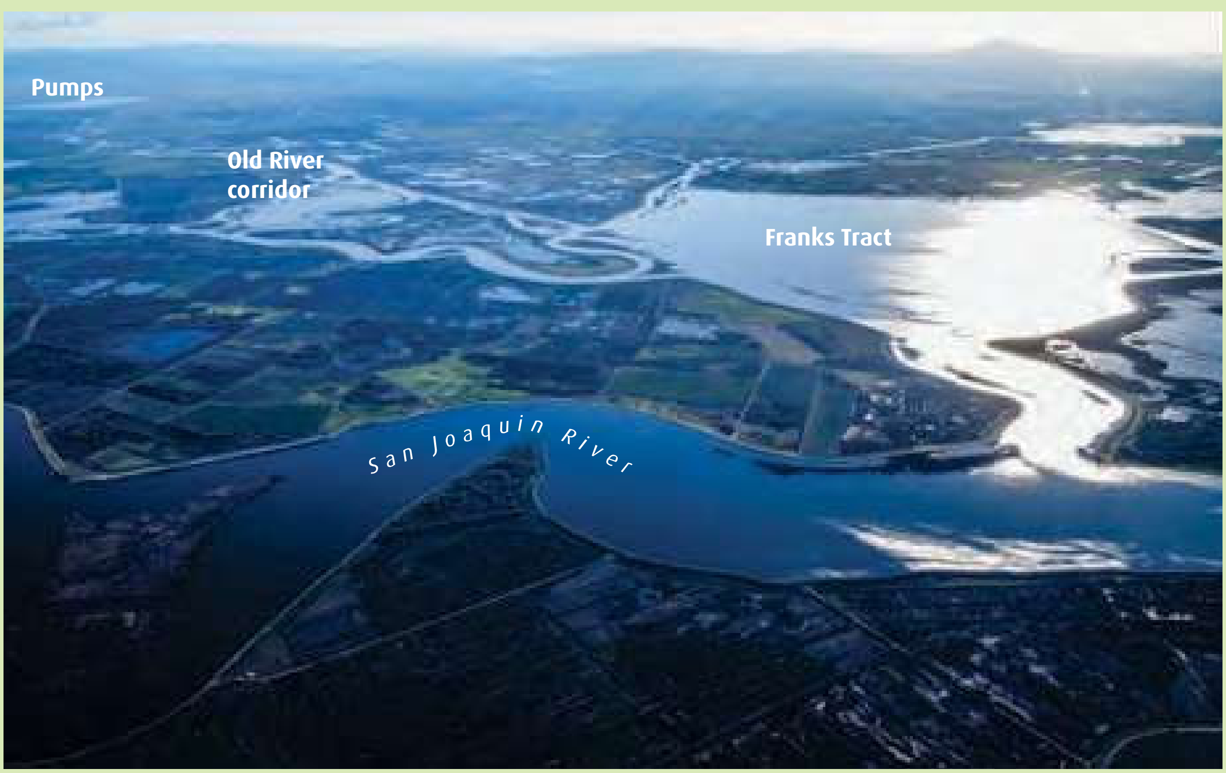


Photo: Christina Sloop

Emergency drought barrier on False River.
Photo: Christina Sloop

ing performed in prior rounds of restoration designs and in support of the 2015 emergency drought barrier suggested that when tides are strongly deflected at False River, energy can be diverted around Bradford Island and cause San Andreas Landing to be saltier. The preferred design appears to dampen the tides at False River sufficiently enough to not cause this type of salinity response.

Sea level sensitivity: The salinity bar chart on p. 61, compares salinity at the three index stations between the No Action and preferred concept scenarios under a modified scenario with 1.8 feet sea level rise. According to the California Ocean Protection Council (2018), this increment represents a 2040 water level under a high greenhouse gas emissions scenario suitable for use in planning for extremely risk averse land uses. As the table shows, sea level rise results in higher values at all three tabulated stations under both geometries. However, the sea level response at Old River at Bacon Island is muted under the preferred design compared to the No Action. This means that in terms of water quality, the project may serve as adaptation to sea level rise.

Drought Protection and Emergency Barrier Deployment

Protection of water quality becomes an elevated management concern during droughts in the central Delta. Whereas salinity encroachment along the main stem of the Sacramento and San Joaquin Rivers can be reversed with increased upstream releases of water and increased flow or a reduction in south Delta pumping, flow management options are limited during a prolonged and extreme drought. Moreover, if salinity does penetrate the freshwater corridor in high concentration, the effect would be largely irreversible. For this reason, the California Department of Water Resources has constructed a barrier to try to limit the transport of salt under extreme circumstances, most recently on False River in 2015 (see also p. 18). The 2015 False River Emergency Drought Barrier achieved its salinity control purpose, but the temporary rock structure was expensive and negatively affected navigation and recreational uses. More ambiguously, the barrier may have also contributed to nuisance invasive vegetation and bivalve population growth (Kimmerer, 2019).

The preferred concept is estimated to provide a significant fraction of the salinity protection of the 2015 emergency drought barrier, and thus can be expected to narrow the range of hydrologic conditions under which a barrier would have to be constructed. Even in a more significant drought, the monolithic design at False River would likely be unnecessary– any structure could be smaller, less costly, and sited to have smaller impacts to regional navigation.

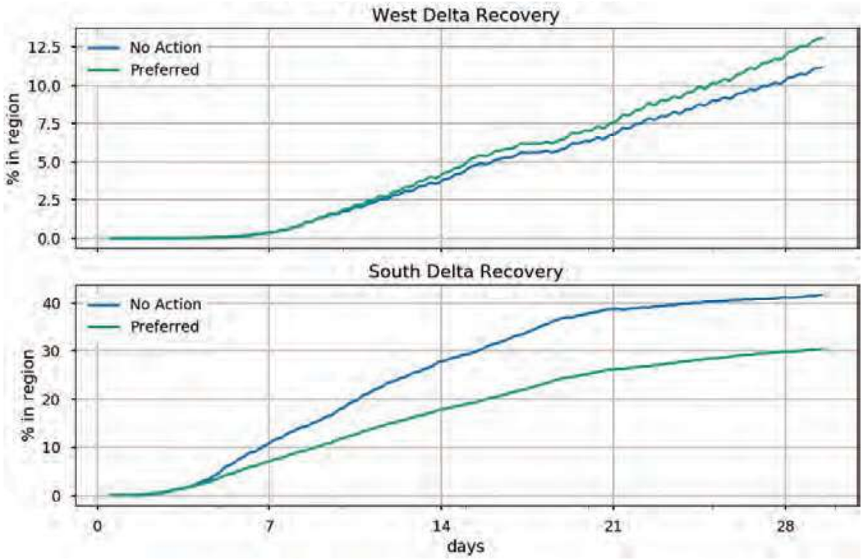
The salinity bar chart on p. 61 depicts the salinities (expressed in units of specific conductivity) resulting from a 2015 simulation under the No Action and preferred concept configurations. Under the preferred concept, salinity at Old River at Bacon Island achieves the basic municipal and industrial criteria of D-1641 (simplified here in terms of conductance as 1000uS/cm) and is 25% lower in concentration than in the No Action without a barrier. With minimal changes, water operations would likely have been able to comply with the regulatory constraints that year, although there would have been little margin for more ambitious targets such as provision of low bromide water for mixing into municipal supplies.

Fish Entrainment and Water Supply Reliability

Entrainment of fish represents not only an ecological risk to listed species, but also a reliability issue for water operations. Under the CDFW (2020) Incidental Take Permit for the State Water Project and federal Biological Opinions by NMFS (2019) and USFWS (2019), presence or salvage of salmon, Delta and longfin smelt and other species at export facilities can trigger Old and Middle River flow restrictions and these limitations are realized through export reductions. Additional entrainment surrogates, such as turbidity triggers, are included for Delta smelt in the permit due to their low population.

Tracking Particles to Simulate Fish Entrainment

March 2015 Release on San Joaquin River near False River



In order to evaluate the effect of the altered flow patterns on entrainment, the planning team performed particle tracking modeling simulations under a variety of hydrologic conditions using three injection sites on the San Joaquin near False River, the mouth of Old River and Turner Cut.

The study does not consider biological behavior but evaluates hydrodynamics that could indicate potential influence on the movement and/or transport of organisms.

The preferred concept reduces potential entrainment influences from the west. The underlying mechanics are the same as those for salinity – the preferred design reduces dispersion from False River to Franks Tract and on to the south Delta.

As shown in the particle tracking chart above, the preferred concept is estimated to reduce potential entrainment influences from west of Franks Tract. For example, in the March 2015 case shown in the chart, the fraction of neutrally buoyant particles injected at Jersey Point that were entrained at the pumping facilities is reduced from slightly over 40 percent to 30 percent. By contrast, potential entrainment influences increase by 3 percent for particles injected on the east side of Franks Tract near the mouth of Old River under similar circumstances, consistent with increases in tidal range of flow at that site. The project has an insignificant effect on potential entrainment influences on Turner Cut, and the specific Franks Tract concepts considered were not particularly influential on particle fate in the western Delta near Suisun.

Particle tracking results do not indicate any reduction in entrainment potential from the Old River/ Mokelumne side of Franks Tract.

Particle Tracking Scenarios

30-day Period from	Characteristics of the period	DTO (cfs)	OMR (cfs)
2010-02-24	High outflow, med OMR	21,231	-4,455
2015-02-25	Low outflow, med OMR	5,349	-3,183
2015-05-01	Low outflow, low OMR	5,163	-1,471

FLOOD PROTECTION

Overview

Two kinds of levees surround the open water areas of Franks Tract: abandoned ones that used to protect Franks Tract and Little Franks Tract from flooding but are no longer maintained, and ones maintained for flood protection that are increasing important as the Delta continues to subside and sea levels rise. The existing, remnant levees of Franks Tract and Little Franks Tract, though breached and eroding (see Introduction p. 5), continue to provide critical wave sheltering for the surrounding intact flood protection levees (e.g., the levees surrounding Bethel Island, Webb Tract, Mandeville Island, and other surrounding islands) in use today.

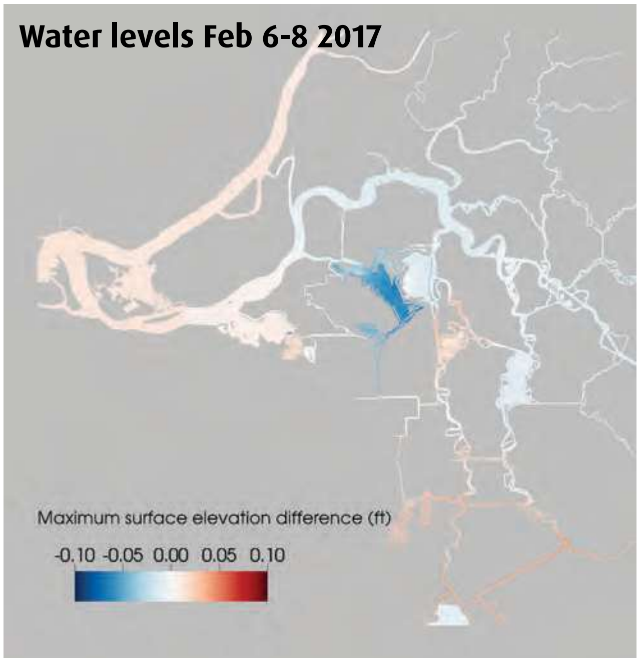
Waves form on Franks Tract during high wind events. The wave-sheltering effect of the remnant levees reduces the risk of wave-induced erosion and overtopping of critical flood protection levees. The Bethel Island Municipal Improvement District and others are interested in project features that enhance the remnant levees in order to reduce required flood protection levee maintenance activities and associated costs.

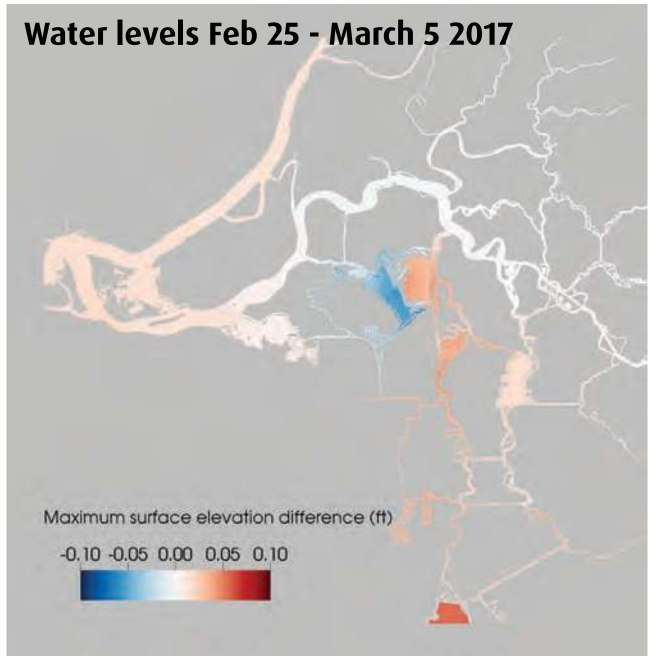
Objectives of the Franks Tract project include improving levels of flood protection, and where possible, avoiding adverse flood impacts. Any project must not worsen flooding during large flood events. If improperly designed, the project could result in higher flood elevations by blocking flow of large runoff events through Franks Tract. Though less likely, the project could also potentially result in higher ocean-driven flood elevations by blocking flow from extreme coastal storm surge events.

Photo: Brett Milligan

The preferred design concept proposes to enhance 12 miles of remnant, sheltering levee around the Tract. The project would raise and widen the remnant levees with dredge or other material, and fill many of the gaps that have eroded in the existing levees over time while retaining key gaps used by boaters.

Flood modeling was conducted on the preferred concept using 2017 flood season data to simulate flood water levels throughout the Delta. Results indicated the preferred concept does not significantly alter flood conveyance or high water levels.





The figures above show plots of the difference in maximum water stage for the preferred concept compared to No Action during the winter 2017 flood season. Changes were less than 0.1 feet everywhere, and mostly less than 0.05 feet. Some areas experience lower peak water levels, some higher. The result that flood conveyance is relatively unaltered generalizes to successive peaks caused by king tides, larger outflows and increased Old and Middle River flows. Subtle differences are apparent based on the watershed origin of the flood waters. The two time periods in Figures 3 and 4 – February 6 through 8 (three days of peak flood levels) and February 25 to March 5 (9 days of high flows on the San Joaquin River), 2017 - show somewhat different results. The latter period resulted in higher differences in the eastern Franks Tract and the south Delta, compared to the early February period. This is believed to be due to high flows in the San Joaquin River.

7 Construction Outlook

Island construction with dredge material. Image courtesy USACE Mobile District, Ship Island Restoration

Rearranging a vast shallow open water area into a new landscape of deeper open water, tidal marshes, new landmasses, navigation channels, recreational beaches, and enhanced remnant levees is an ambitious construction task. The Franks Tract 2020 project conducted an assessment of construction options, reviewing feasibility and engineering constraints, types of onsite fill material, duration of construction, and unit rates for movement of material.

The assessment concludes that the preferred design concept is feasible to construct. About 37 million cubic yards of earth would need to be moved. Planners estimate construction costs of about $560 million. Costs could be lowered by reducing the area of constructed land mass in Franks Tract and Little Franks Tract. The duration of the construction period is estimated at four to nine years minimum.

This assessment builds on and updates methods developed for the 2018 Franks Tract Futures feasibility report. The prior study considered multiple sources of fill material and concluded that using local material dredged from Franks Tract was the least cost alternative; this approach has been integrated into the 2020 effort.

Constructability

Marine Equipment

As there are no roads to Franks Tract, or any access over land to the project area, construction would be accomplished using marine-based construction equipment. Shallow water depths hamper access. Access via navigable water includes False River, West False River, the San Joaquin River, Old River, and Piper Slough. Construction equipment would not make use of Piper Slough, in order to protect access to that waterway by Bethel Island residents and boaters in the area.

Local Fill

The construction approach is to use local material dredged from within Franks Tract, deepening select areas to create the proposed land masses. Local material dredged from within the Tract is the least cost source of fill and is available in sufficient quantities to construct the preferred concept. This approach achieves the shortest distance between the dredging and placement areas.

Using local material reduces the cost of transportation and handling of material, and energy usage and emissions, compared to other construction methods. Sourcing the material from within the Tract also saves costs, in terms of buying and importing sand, and saves time in the overall construction schedule. As such it is the least cost method.

Based on past land uses, the dredge material is expected to be clean and suitable for use in creating the tidal marsh land masses and other features. Sand is an ideal material for building up the proposed landforms, and the peat content will aid in propagation of marsh habitat.

Building the Land Masses

The planning team envisions using a large cutter suction dredge to remove and place the material to create the new landmasses. This vessel has the ability to dredge to the required depths. This dredge uses a cutter-head attached to the end of a long boom or pipe mounted to the bottom of the vessel (termed a ladder). In terms of equipment, the cutter-head is particularly suited to dredging the material at Franks Tract, which includes poorly graded sand, silty sand, and peat. Most large cutter suction dredges for this type of project work 24 hours per day 7 days per week.

TOP: Cutter suction dredge and floating pipeline. Image courtesy Van Oord. UPPER MIDDLE: Dredge material placement. Image courtesy USACE Mobile District, Building Ship Island. LOWER MIDDLE: Pipeline spread for dredge material placement. BOTTOM: Low ground pressure amphibious excavator.

Construction crews will move material from the dredge vessel to the point of discharge on the new landmasses via a floating pipeline. The discharge end of the pipeline will be mounted on a flat deck barge, which enables the pipeline to be positioned near the material placement site. The dredged sand and peat will be transported in the pipeline in the form of a slurry, which contains about 15 to 35 percent dredge material by weight mixed with water.

A large cutter-suction dredge should have sufficient pump capacity to transport the material over the distances required. In the event that additional pump capacity is required, crews can deploy a booster station. This consists of an additional pump mounted on a floating platform to augment pumping capacity.

In sum, gross placement of material for the landmasses will be via the dredge and mobile discharge point (barge). Once crews have established the basic form of the landmasses, they will use a spread of pipeline segments for additional shaping and placement. Final shaping of the landmasses will be completed using low ground pressure construction equipment (dozers and excavators).

Working on Levees, Channels & Beaches

The preferred design concept calls for upgrading the remnant perimeter levees to a 25-foot-wide crest at an elevation of approximately +9 feet NAVD88, or high enough not to be overtopped during high water but low enough not to obstruct views. Crews will use dredge equipment to pump and discharge construction material along the levee crest where a dozer will push the material out along the levee. An excavator will work to shape the side slopes of the levee and create the final profile. Where the design calls for more detailed material placement, an excavator will pick up and place material from a barge brought in alongside the levee (see photos).

The design also calls for the excavation of marsh channels during final shaping of the landmasses using low ground pressure excavators capable of operating on the material placed for the landmasses and at elevations subject to tidal variation.

The easiest way to construct the through-channels may be to place the gross material for the landmasses first, and subsequently use the dredge or an excavator to cut the through channels. This will allow better control over the location of the channel edge, desired channel dimensions, and creation of the target 4H:1V side slopes. Final grading of the channel side slopes will require an excavator.

Building public use beach areas may require "clean sand." If beach building requirements cannot be met with sand dredged from Franks Tract, it may need to be imported. Local sand may include too much peat or silt, or be too fine or coarse, or the wrong color, for desired beach aesthetics.

Peat Thickness. *Average peat layer thicknesses across Franks Tract. The data derives from borings within Franks Tract (HLA 1990), from adjoining islands and tracts (USGS 1982), and Jersey Island and Bouldin Island quadrangle sheets. The data suggests that the deepest peat deposits exist around the northeast extent of Franks Tract, with layer thicknesses of around 25 feet deep. Going east to west, the thickness of the peat deposits decreases gradually to around 10 feet deep in the center of Franks Tract, down to less than five feet at the transition to Little Franks Tract. By comparison, peat deposits on Sherman Island on the west side of the San Joaquin River are as much as 55 feet deep. Source: Moffat & Nichol 2017.*

Construction Fill Quantities

The estimated volume of material needed to construct the proposed alternative is on the order of 37 million cubic yards (mcy). Dredge volume is the amount of material dredged onsite to build up landmasses and enhance the existing remnant perimeter levees. The planning team calculated volume as the difference between constructed and existing grade, including an allowance for settlement. Constructed grade for the marsh surface generally ranges from 3.5 to 6.5 feet NAVD88, 8 to 11 feet above typical existing grade.

Gross Quantities for Fill Areas for the Preferred Concept

Restoration Quantity	Preferred Concept
Marsh Area (acres)	1,370
Recreational Use (acres)	12
Fill to Grade (CY)	25,834,000
Consolidation (CY)	11,401,000
Total Fill/ Dredging (CY)	**37,235,000**

CY = Cubic Yards

The planning team augmented fill quantities to compensate for consolidation, which will occur during landmass construction. The added weight of the fill causes underlying layers of peat to consolidate, requiring more fill to reach target elevations for marsh. The precise dredge and fill quantities will depend on the finalized concept, detailed design for construction, and geotechnical analysis to confirm the extent of sand and peat within the Tract (see peat contours map above). The preferred concept for landscape redesign at benefits from landmasses being mostly located in areas of shallow peat deposits, which reduces the amount of fill needed to compensate for consolidation.

Schedule

Project construction would likely take 4 to 9 years if allowed year-round, and longer depending on environmental windows protective of fish. The amount of peat involved could present considerable engineering challenges. More detailed analyses could clarify these challenges before construction.

The shortest construction duration assumes work 24 hours per day, 7 days a week. The longer duration estimate assumes construction occurring on weekdays only, with no weekend or nighttime construction. The shortest construction duration may be achievable if noise and visual impacts can be limited to an acceptable level for local communities. Lights would be needed during nighttime construction. A 24-7 approach is the most efficient in terms of the use of the dredge and construction equipment.

Noise associated with construction will primarily be from pumps and conventional diesel-powered equipment. Conventional equipment is currently being modernized, however, allowing options to diesel that could benefit the project. Hybrid construction equipment can run with a smaller engine at a lower rpm. Fully electric systems run on rechargeable lithium-ion batteries. Electric pumps of the size needed for the project are already available on the market. While delivery of electrical power to the site poses a unique challenge, use of hybrid or all-electric equipment would mean a significant reduction in construction noise and particulate emissions.

The schedule will additionally depend on environmental windows protective of fish. In-water work should occur during standard in-water work windows. The in-water work windows are August through November for Delta smelt and July through October for salmonids.

The schedule could also be affected by efforts to minimize impacts on hunting, fishing and other seasonal activities important to local residents and the economy.

Construction Costs

The planning team estimates unit costs for the project on the order of $15.35 to $16.45 (circa 2020) per cubic yard placed. This includes the contractor's mobilization, transfer of the dredge and floating pipeline to the site, contractor's marine equipment, installation of silt curtains for turbidity control for fisheries, construction of the tidal marsh land masses, enhanced remnant perimeter levees, beaches and other public areas; demobilization, and indirect costs, bonding, and insurance.

These unit costs are based on:

- One mobilization and one de-mobilization, i.e. contractor's equipment remains at the construction site from start to completion.
- No standby time is included for settlement of the placed fill. Construction may be scheduled so that settlement of fill material placed for one island can go on while construction continues on other islands.
- All equipment is assumed to be conventional diesel-powered equipment (though cleaner newer hybrid equipment may be preferable if affordable), with the following fuel factors: Diesel ($/Gal): 2.75; Gasoline ($/Gal): 3.10; Electricity ($/kW): 0.087; Offroad ($/Gal): 2.90.
- Costs for permits, engineering, design, and geotechnical exploration are not included.
- Costs for revegetation are not included. Revegetation would rely on a combination of natural vegetation colonization processes and planting of native plants. Adding planting efforts would increase the overall cost estimate.
- Weed abatement efforts would be higher during the initial period of native plant establishment. The incremental costs of initial abatement are not included. Long-term weed abatement costs are discussed in Operations and Maintenance (p.67).
- Dredging and fill operating on a 24 hour per day, 7 day per week schedule. Any limitations on a 24 hour per day, 7 day per week schedule would lengthen the overall construction schedule and increase costs.

A breakdown of costs for the construction activities described above is included in the table opposite.

Construction Activity	Cost Estimate
Dredging operations[1]	$358,426,000
Management of fill to build up levees and create tidal marshes	$147,349,000
Shaping and excavating channels in tidal marshes[2]	$51,619,000
Construction of beaches and public areas (5 beach areas)	$1,970,000

1 - Does not include costs for maintenance dredging. The dredge areas, tidal marshes, and channels are assumed to be self-sustaining and not require maintenance dredging.
2 - Based on excavation of 7,092,000 cubic yards of material. Slope armoring (if any) and revegetation costs are not included.

Construction Impacts

Short term disruptions would occur during construction of the project. Activities such as dredging and land mass shaping would be ongoing over a period of several years with associated noise, navigation re-routings, etc. Staging construction (building one land mass at a time) could minimize impacts but also affect the duration of the project. If a project were to be implemented, further discussion would be needed to determine how to best schedule and sequence any future construction to accommodate existing Franks Tract uses (e.g. localized shutdowns during key hunting or fishing periods, weekend shutdowns, etc.) and how to best mitigate or abate any short term construction related impacts.


Photo: Brett Milligan

Operations & Maintenance

A commitment to operations and maintenance of project features is a key component and cost of its long-term success. Ongoing demands would include maintenance of the proposed recreational facilities, and ongoing aquatic weed management. However, the project also has the potential to reduce other kinds of activities such as periodic deployment of an emergency drought barrier and maintenance of flood protection levees on surrounding islands.

Ongoing activities are envisioned to include maintenance and upkeep of the public access points, docks, camp sites, day-use areas, picnic and beach areas, restroom facilities, and trash receptacles. Costs may include labor for State Parks staff, equipment, boat, supplies, materials, and services. These operations and maintenance costs for new amenities are estimated at approximately $370,000 per year (2020 cost without escalation).

Continued treatment of submerged and floating aquatic vegetation will also be critical to effective site management. The project would not necessarily change the cost of ongoing aquatic weed management. The project would, however, change the types of habitats and water depths at the site, helping weed management dollars go further. The preferred concept will reduce the amount of area at high risk for aquatic weed colonization, therefore, the same level of effort could be applied to the tract with more beneficial results. The current level of effort for weed control at Franks Tract is approximately $4-8 million/year, based on the treatment of approximately 1,000 – 2,000 acres of submerged aquatic vegetation in Franks Tract at a cost estimate of $4,000 per acre (Conrad, 2019 and L. Anderson, personal communication).

The project could also reduce the operation and maintenance costs of deploying emergency drought barriers (see p.18). Salinity improvements with the proposed Franks Tract project will tend to reduce the frequency of conditions likely to result in new barrier deployments. Even a modest reduction in deployment frequency could be significant from a cost and disruption perspective.

Finally, the project will reduce near-term maintenance of flood protection levees. Enhancement of the remnant perimeter levees will provide continued wave sheltering to the nearby flood protection levees serving surrounding communities (e.g., the levees on Bethel Island maintained by the Bethel Island Municipal Improvement District). Consequently, adjacent levee maintenance districts and reclamation districts are expected to benefit from lower levee maintenance

8 Outlook for the Future

The landscape redesign and enhancement actions developed and selected through the 2019-2020 co-design process described in this report suggest a bold, sustainable change in the heart of the Delta. Stakeholders recognize that any feasible project must achieve multiple benefits to generate sufficient public and financial support for what would be a major construction effort. In addition, any project must ultimately be supported by the local community to move forward.

Key Findings

- *At the highest level for consideration, a redeveloped Franks Tract offers an opportunity for improvements in recreation, navigation, ecology, water quality and other community benefits.*
- *The Project Team, Advisory Committee, Steering Committee and the public agree that Concept B Central Landmass currently offers the best balance and best opportunity to build upon for a reimagined Franks Tract moving forward.*
- *Stakeholder and public preference evolved over the course of this approximately one-year planning effort. For the Advisory Committee and Steering Committee, initial support for the No Action alternative and early versions of Concept C Eastern Landmass shifted to selection of Concept B as the Preferred Concept. Early public preference was overwhelmingly for the No Action alternative; later public preference was for some version of a project at Franks Tract.*
- *There would be unavoidable trade-offs with any project, especially with respect to costs and construction impacts. Both construction and long-term operations and maintenance costs would be much higher for any of the three concepts relative to the No Action alternative. There are, however, opportunities to reduce long-term costs associated with levee maintenance and emergency drought barriers, and the opportunity to achieve more benefits with a fixed budget for aquatic weed removal.*

What's Next?

- Identification of responsible agencies and sources of funding would be necessary next steps if the project is to move forward. Figuring out 'who pays' would need to be aligned with the agencies and organizations with the most to gain.
- Before any project would move forward, a commitment to long-term operations and maintenance funding would need to be put in place. The development of recreational features and uses is dependent on securing a sustained funding source to develop, manage and maintain them. Likewise, the development of ecological and water quality features is dependent on the identification of responsible agencies and sources of funding for construction and ongoing management.
- Since cost remains a high-level feasibility issue, the next phase would explore project refinements to reduce overall costs.
- Stakeholder and public engagement were critical to shaping the final concepts to reflect community values for this phase of planning and will need to be carried into any future work to ensure consistency with project goals and objectives.
- Enhancing recreational opportunities is a must to the local community. A project without a robust recreational component and reliable sources of funding to maintain this component will lose community support.
- Various important finer scale considerations – such as detail for the recreational amenities, revegetation plans, etc. – would need to be explored in any future planning, design and environmental review process.

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CALIFORNIA DEPARTMENT OF FISH & WILDLIFE

Appendix B
Mitigation, Monitoring and Adaptive Management Plan for the LSJR Feasibility Study

ENVIRONMENTAL ADDENDUM J

MITIGATION, MONITORING, AND ADAPTIVE MANAGEMENT PLAN

LOWER SAN JOAQUIN FEASIBILITY STUDY

Habitat Mitigation, Monitoring, and Adaptive Management Plan

Lower San Joaquin River Feasibility Study

December 2017

US Army Corps of Engineers

CENTRAL VALLEY FLOOD PROTECTION BOARD
STATE OF CALIFORNIA

SJAFCA
San Joaquin Area FLOOD CONTROL Agency

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Acronyms and Abbreviations

AAHU	Average Annual Habitat Unit
BA	biological assessment
BO	biological opinion
CE/ICA	cost effectiveness/incremental cost analysis
Corps	U.S. Army Corps of Engineers
DSM	deep soil mixing
DWR	California Department of Water Resources
DWSC	Deep Water Shipping Channel
EIS/EIR	environmental impact statement/environmental impact report
ERDC	Engineer Research and Development Center
ETL	Engineering Technical Letter
GRR	general reevaluation report
GGS	giant garter snake
HEP	Habitat Evaluation Procedures
HMMAMP	Habitat Mitigation, Monitoring, and Adaptive Management Plan
HSI	Habitat Suitability Index
HU	Habitat Units
IEP	Interagency Ecological Program
IWG	Interagency Working Group
IWM	instream woody material
IWR	U.S. Army Corps of Engineers Institute for Water Resources
IWR Plan	Institute for Water Resources Planning Suite
LSJR	Lower San Joaquin River
NMFS	National Marine Fisheries Service
O&M	operation and maintenance
PED	preconstruction engineering and design
ppt	parts per thousand
RD	reclamation district
RM	river mile
SJAFCA	San Joaquin Area Flood Control Agency
SRA	shaded riverine aquatic habitat
SMART	specific, measurable, attainable, realistic, and timely
USC	United States Code
USFWS	U.S. Fish and Wildlife Service
V	variable
VELB	valley elderberry longhorn beetle
WRDA	Water Resources Development Act

1.0 INTRODUCTION

1.1 Purpose and Goals

Mitigation for habitat loss is a requirement to compensate for the loss of habitat due to a Federal action. Section 906(d) of the Water Resources Development Act (WRDA) of 1986 states that project alternatives must support recommendations with a specific plan to mitigate fish and wildlife losses. Additionally, the Endangered Species Act (ESA) states that the purpose of compensatory mitigation is to offset environmental losses resulting from unavoidable impacts.

The primary purpose of habitat monitoring is to determine the level of ecological function at each mitigation site as a part of an overall plan to create sites that offset the loss of habitat affected by construction of the proposed project. This Habitat Mitigation Monitoring and Adaptive Management Plan (HMMAMP) describes the types of habitats that will be impacted, the potential impacts caused by the project, and the types and amounts of mitigation that would be established in order to compensate for habitat losses. This plan also establishes methods to evaluate the success of these sites and includes adaptive management measures to be implemented if success criteria are not being met to ensure the goals and requirements of the project's mitigation are accomplished. This HMMAMP is a living document and may be modified as part of an adaptive management strategy to allow for goals and requirements to be accomplished in a constantly changing environment. This HMMAMP will accompany the final EIS/EIR as part of the project addenda, and will be updated throughout the project design phase as detailed design efforts allow for finalizing the mitigation plans.

The goal of the HMMAMP is to ensure that the conservation values of the mitigation sites are maintained in good condition in perpetuity. The plan's biological goals are to: (1) preserve the abundance and diversity of native species (particularly special status species) in the established habitats in the project area; (2) protect the habitat features from the effects of indiscriminate land use changes that may adversely impact mitigation habitats; and (3) mitigate any adverse impacts within the project areas. Monitoring would be conducted in a manner compatible with the type of mitigation site. Mitigation requirements are provided by the U.S. Fish and Wildlife Service (USFWS) and the National Marine Fisheries Service (NMFS) through biological opinions (BOs) received through the Endangered Species Act Section 7 consultation process. Additional mitigation recommendations from USFWS are included in the project's Fish and Wildlife Coordination Act Report.

The HMMAMP would be implemented by U.S. Army Corps of Engineers (Corps) staff through coordination with USFWS and NMFS. Monitoring would be conducted by qualified biologists from the Corps, in coordination with the USFWS, the California Department of Water Resources (DWR), and the San Joaquin Area Flood Control Agency (SJAFCA). Upon completion of construction (to include the plant establishment period for the site), the land would be turned over to the non-Federal sponsor to be maintained in perpetuity.

1.2 Project Description

The Lower San Joaquin River (LSJR) study area is located along the lower (northern) portion of the San Joaquin River system in the Central Valley of California. The San Joaquin River originates on the western slope of the Sierra Nevada and emerges from the foothills at Friant Dam. The river flows west to the Central Valley, where it is joined by the Fresno, Chowchilla, Merced, Tuolumne, Stanislaus and Calaveras rivers, and smaller tributaries as it flows north to the Sacramento-San Joaquin Delta.

The study area, as defined in the study authorization, includes the main stem of the San Joaquin River from the Mariposa Bypass downstream to the city of Stockton. The study area also includes the distributor channels of the San Joaquin River in the southernmost reaches of the Delta: Paradise Cut and Old River as far north as Tracy Boulevard and Middle River as far north as Victoria Canal. Based on availability of potential non-Federal sponsors, the study focused on approximately 305 square miles encompassing incorporated areas of Stockton, Lathrop, and Manteca as well as unincorporated portions of San Joaquin County. During the plan formulation process, the study area was divided into three separable elements. The separable elements are considered to be hydraulically separate, meaning that each area could have stand-alone solutions or alternatives proposed to address flood risk. The separable elements are shown on Figure 1 below.

Figure 1. LSJR Study Area Map

Manteca, and surrounding unincorporated portions of San Joaquin County. These areas have experienced multiple flooding events since records have been maintained. The existing levee system within the study area protects over 71,000 acres of mixed-use land with a current population estimated at 264,000 residents and an estimated $21 billion in damageable property.

The study area includes:

- The San Joaquin River between French Camp Slough and the railroad bridge 14 miles below the Stockton Deep Water Shipping Channel (DWSC);
- French Camp Slough from El Dorado Street to the San Joaquin River; the Calaveras River from N. El Dorado Street to the San Joaquin River;
- Portions of the Stockton DWSC between Smith Canal and Fourteenmile Slough;
- The west side of Fourteenmile, Tenmile Slough, and Fivemile Slough to Mosher Slough; and
- The south side of Mosher Slough .41 miles beyond N. Eldorado Street up to the railroad tracks.

The Corps has identified a number of problems associated with the flood risk management system protecting the city of Stockton and surrounding areas. There is a high probability that flows in the lower San Joaquin River, Calaveras River, and the Sacramento-San Joaquin estuary (the Delta) or a seismic event would stress the network of levees protecting Stockton to the point that they could fail. The consequences of such a levee failure would be catastrophic, since the area that would be inundated by flood waters is densely urbanized and the flooding could be up to 18 feet deep.

Most levees in the study area require seepage and slope stability improvements in order to meet Corps levee design criteria. Some levees require slope reshaping, height improvements, and/or erosion protection. The northern portion of the project area is vulnerable to flooding from the west (the Delta). Options to improve existing levees immediately adjacent to the city of Stockton to reduce risk from this threat are constrained due to urban development. Therefore, two in-water closure structures are also proposed. In the southern part of the project area a new levee extension is proposed on Duck Creek.

During Pre-Construction, Engineering, and Design Phase (PED), engineering investigations will be conducted to determine the suitability of the Recommended Plan levees for a vegetation variance to allow some vegetation to remain on the lower portion of the waterside levee slope of the levees and within the waterside easement.

The Recommended Plan (Alternative 7a) for the LSJR study is to improve the levees in the study area to address identified seepage, stability, height, and erosion concerns. The Recommended Plan is composed of different structural measures, or building blocks, to address these problems. The measures are described below in this section. Overall, the Recommended Plan includes: (1) 19.4 miles of seepage cutoff walls; (2) 3.2 miles of geometric improvements consisting of levee slope and crown reshaping to meet Federal standards; (3) 3.5 miles of levee height raises mainly to reestablish the design levee height; (4) 0.5 miles of flood walls/sheet pile walls; (5) 1.1 miles of seismic improvements, (6) 0.75 miles of new levee, and (7) 5 miles of new erosion protection (a majority of the new protection would be on the landside only; however, existing erosion protection disturbed by construction would be replaced). Note that these features overlap one another and cannot be added up to describe the total project extent. The total amount of horizontal flood features (including closure structures) is approximately 24.5 miles. The Recommended Plan is shown below on Figure 2 and described in Table 1.

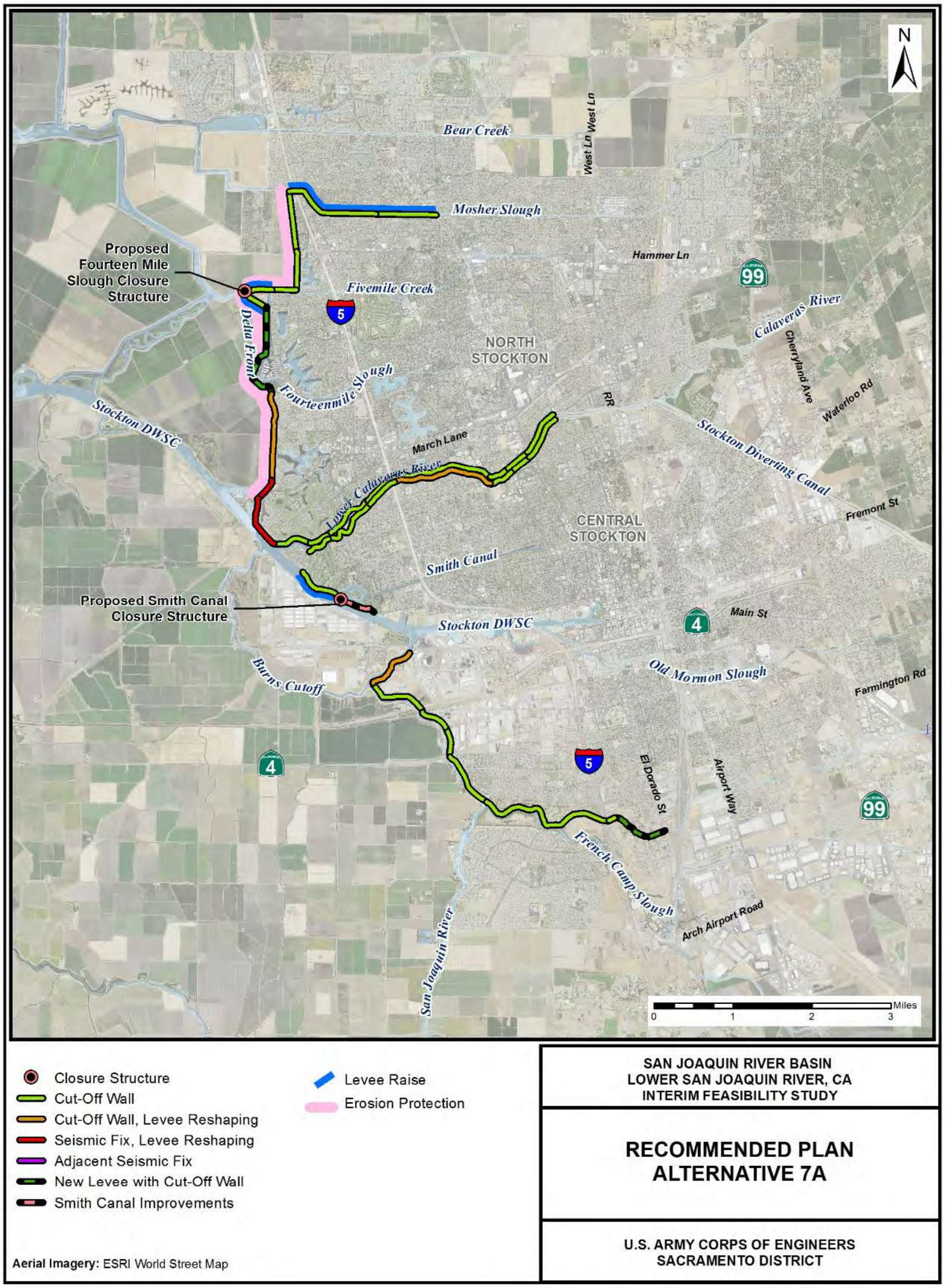

Figure 2. The LSJR Study Recommended Plan.

These measures would be implemented primarily by fixing levees in place. In addition to levee improvements, the Recommended Plan includes two in-water closure structures. Once a levee is modified, regardless of the measure implemented for the alternative, the levee would meet the Corps' levee design criteria. This would include slope reshaping and/or crown widening, where required. The levee crown would be widened to 20 feet minimum on the San Joaquin River and 12 feet minimum on all other levees included in the Recommended Plan. Both landside and waterside slopes of 3H:1V would also be established where possible. If necessary, the existing levee centerline would be shifted landward in order to accommodate levee reshaping and height improvements.

In addition to the structural features, the Recommended Plan also includes several non-structural features to further reduce the consequences of flooding, including Comprehensive Flood Warning Emergency Evacuation Planning and Floodplain Management.

Table 1. Proposed Measures for the LSJR Study Recommended Plan.

Waterway	Reach	Proposed Measure(s)
North Stockton		
Mosher Slough	Thornton Road to UPRR railroad tracks	Cutoff wall
Mosher Slough	Shima Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)
Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)
Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)
Fourteenmile Slough	Fivemile Slough to Proposed Closure Structure	Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	Approximately 1,500 feet west of Fivemile Slough	Closure Structure
Fourteenmile Slough	Approximately 1,250 feet southeast setback out from proposed closure structure	Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	From setback cut south to Tenmile Slough	Adjacent levee Slope Reshaping Erosion protection (landward)
Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope Reshaping Erosion protection (waterside)
Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic Fix Slope Reshaping Erosion protection (waterside)
Tenmile Slough/ Buckley Cove Marina/ San Joaquin River	West March Lane/Buckley Cove Way to Calaveras River	Seismic Fix Slope Reshaping
Calaveras River – Right/North Bank	San Joaquin River to North El Dorado Street	Cutoff wall
Central Stockton		

Waterway	Reach	Proposed Measure(s)
Calaveras River – Left/South Bank	San Joaquin River to approximately I-5	Cutoff wall
Calaveras River – Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping
Calaveras River – Left/South Bank	Approximately North Pershing Avenue to approximately El Dorado Street	Cutoff wall
San Joaquin River	From approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)
Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure Structure
Smith Canal	Dad's Point from the Closure Structure to approximately 375 feet down Monte Diablo Avenue	Floodwall
San Joaquin River	Railroad bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping
San Joaquin River	Burns Cutoff to French Camp Slough	Cutoff wall
French Camp Slough – Right/North Bank	French Camp Slough confluence with the San Joaquin River to approximately 500 feet southwest of I-5	Cutoff wall
Duck Creek	500 feet past I-5 cross to approximately Odell Avenue	New levee
Duck Creek	Approximately Odell Avenue to McKinley Avenue	Cutoff wall Levee reshaping Levee Height Fix

1.3 Description of Proposed Protective Measures

1.3.1 Bank Protection

The new erosion protection included in the Recommended Plan will be placed either on the waterside of the levee or on the landside of the levee. All of this new erosion protection would be placed above the waterline. The purpose of the North Stockton erosion protection is to protect the project levee from wind and wave run-up erosion which could occur if Delta levees to the west of the project levee were to fail allowing flooding of land immediately west of the project levee. The purpose of the Central Stockton erosion protection on Duck Creek is to protect the backside (landside) of the levee from erosion that could occur if floodwaters moving from the south to the northeast were to wrap around the end of the project levee and back up against it. Although this would be the only placement of new erosion protection, any existing riprap disturbed during construction of project features would be replaced. When necessary, the eroded portion of the bank would be filled and compacted prior to the rock placement. The sites would be prepared by clearing and stripping the site prior to construction. Small vegetation and loose materials would be removed. In some cases, large vegetation would be permitted to remain at these sites. Temporary access ramps would be constructed, if needed, using imported borrow material that would be trucked to the site.

1.3.2 Levee Geometry

Levee reshaping involves grading high areas and or placing additional soil in depressions and compacting it in order to restore the levees to Corps levee design criteria for side slopes and crown width. For the Recommended Plan, the minimum crest width for major tributary levees is 20 feet and the minimum crest width for minor tributary levees is 12 feet. Existing levees with landside and waterside slopes as steep as 2H:1V (i.e., for every 2 feet of horizontal distance, there is a 1 foot increase in height) may be acceptable if slope performance has been good and if the slope stability analyses determined the factors of safety to be adequate, otherwise the landside and waterside slopes should have 3H:1V slopes. This improvement measure addresses problems with slope stability, geometry, and levee toe and crest access and maintenance. To begin levee embankment grading, the area would be cleared, grubbed, stripped, and, where necessary, portions of the existing embankment would be excavated to allow for bench cuts and keyways to tie-in additional embankment fill. The existing levee centerline would be shifted landward where necessary in order to meet the Corps standard levee footprint requirements. The levee crown patrol road would be re-established and a new toe access corridor would be added 10 feet landward of the levee toe.

1.3.3 Cutoff Walls

To address seepage concerns, a cutoff wall would be constructed through the levee crown (Figure 3. A cutoff wall is a water resistant barrier that is constructed vertically into the levee and is designed to prevent through and underseepage in the levee. The cutoff wall would be installed by one of two methods: (1) conventional open trench cutoff walls, or (2) deep soil mixing (DSM) cutoff walls. The method of cutoff wall selected for each reach would depend on the depth of the cutoff wall needed to address the seepage. The open trench method can be used to install a cutoff wall to a depth of approximately 80 feet. For cutoff walls of greater depth, the DSM method would be utilized.

Prior to construction of either method of cutoff wall, the construction site and any staging areas would be cleared, grubbed, and stripped. The levee crown would be degraded up to half the levee height to create a large enough working platform (approximately 30 feet) and to reduce the risk of hydraulically fracturing the levee embankment from the insertion of slurry fluids.

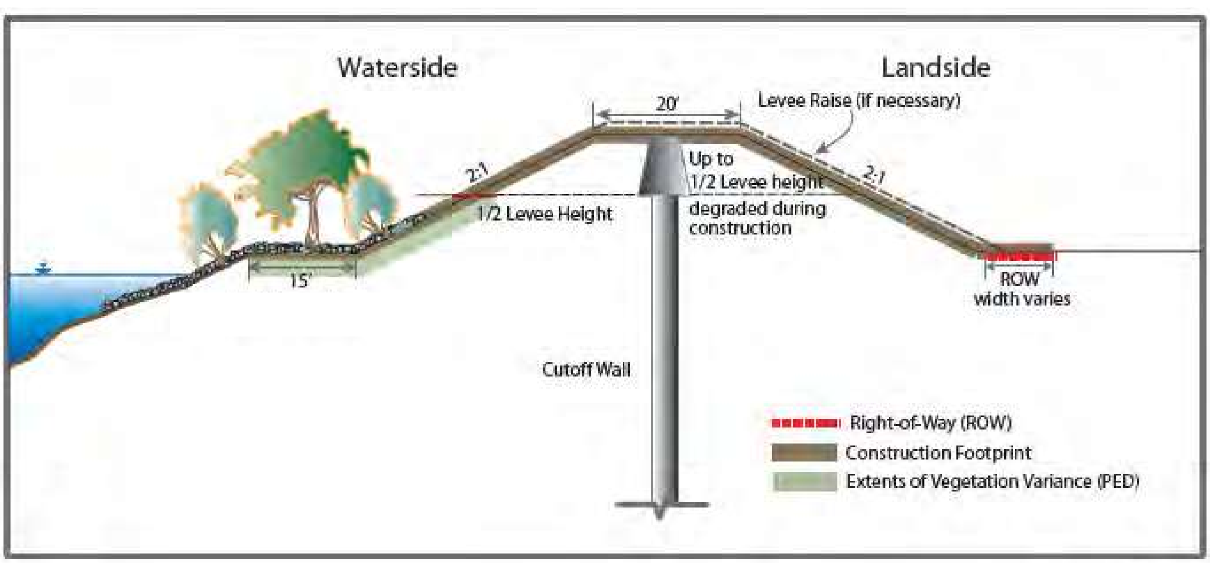

Figure 3. Fix-in-place with Cutoff Wall.

1.3.4 Levee Raise

This measure would be implemented to repair the levee height in locations where the crown has slumped and to raise the existing levee height to reasonably maximize net benefits. To raise the levees, additional borrow material would be added after cutoff walls and levee reshaping improvements are completed. The additional material would be brought from nearby borrow sites, stockpiled in staging areas then hauled to the site with trucks and front end loaders. Material would be spread evenly on the levee and compacted according to levee design plans. The levee would be hydroseeded once construction was completed.

In some locations, the levee height could increase up to 5 feet; however, most raises would be 1.5 to 3 feet. An increase in levee height may require additional levee footprint area to meet design requirements for minimum levee slope and crown width.

1.3.5 Flood Walls

This measure consists of construction of about 825 linear feet of sheetpile floodwall from the southern portion of Dad's Point to high ground at Louise Park. The wall height would be an average of three to four feet above the ground surface. A metal cap may be placed on the top of the sheetpile or the sheetpile maybe encased in concrete. The floodwall would be approximately 12 to 18 inches wide. To begin the floodwall construction, the area would be cleared, grubbed, stripped, and excavation would occur to provide space to construct the footing for the floodwall. The floodwall would primarily be constructed from pre-fabricated materials, although it may be cast or constructed in place. The floodwall would be constructed almost completely upright. Floodwalls mostly consist of relatively short elements, making their connections very important to their stability. The floodwalls would be designed to disturb a minimal amount of waterside vegetation.

1.3.6 New Levee

This measure would involve constructing new levees to reduce the flood risk to some areas or to prevent waters from outflanking (i.e., flowing around the ends of the levees and entering the area intended to be protected) the existing levee system during high water events. A new levee is planned for the upstream 0.75 mile of Duck Creek to tie the existing levee into the railroad berm along the north side of Duck Creek. To construct the new levee, the construction footprint area would be cleared and grubbed and a new levee foundation would be excavated. A levee inspection trench would be excavated across the entire proposed centerline of the new levee. The depth of the inspection trench would vary depending upon levee height, as required by Corps guidance and the State's Urban Levee Design Criteria. For the purposes of the impact analysis, a depth of 3 to 6 feet is assumed.

Construction of the new levee section would proceed in accordance with Corps levee design criteria, with suitable material placed in 6- to 8-inch lifts, moistened, and compacted to design specification until the design elevation has been reached. A cutoff wall would be constructed through the center of the new levee, if needed, to prevent through- and under-seepage. For new levees that require erosion protection, quarry stone riprap would next be applied to armor the newly completed levee's waterside slope and provide protection against erosion. Fill material for levee construction would be obtained from local construction borrow areas and commercial sources, and would be delivered to the levee construction sites using haul trucks. A gravel road would be constructed on the crown of the new levees. Following construction, the levee slopes would be reseeded with native grasses to prevent erosion.

1.3.7 Seismic Remediation

This technique is meant to keep the levee from deforming or liquefying during seismic activity. It would be implemented to provide seismic stability to the somelevees of North Stockton that are frequently loaded (due to tidally influenced slough water surface elevations) and that are also subject to potentially significant deformations due to a seismic event. It would involve installation of a grid of drilled soil-cement mixed columns (Figure 4-5 of the Main Report). There would be a series of overlapping, DSM columns aligned longitudinally with and transverse to the alignment of the levee extending beyond the levee prism. This measure would also reduce risk of seepage and provide improved landside slope stability.

The crest of the levee would be reconstructed to comply with the USACE levee design criteria. DSM augers would be used to construct a continuous grouping of cells spaced equally in both longitudinal and transverse directions to the levee alignment. A hose attached to the auger would inject cement bentonite slurry into the soil, allowing for DSM. After construction is completed, the levee crest would be topped with a 6-inch aggregate road and the slopes would be hydro-seeded for erosion control. This effort would occur along 1.1 miles of Tenmile Slough.

1.3.8 Closure Structure

This measure would include construction of closure structures at the mouth of backwater sloughs at Smith Canal and on Fourteenmile Slough to reduce flood risk along those sloughs. The structure would extend from the end of Dad’s Point to the right bank of the San Joaquin River at the Stockton Golf and Country Club. The closure structures would control back-flooding from the San Joaquin River and Delta during high water events. The proposed closure structures would consist of a fixed sheet pile wall structure (about 800 feet long) with an opening gate structure sufficiently large to allow for the safe passage of boats and other watercrafts. The opening portion of the closure structure would be an automated gate that may open upward or outward. The gate would be approximately 50-feet wide, and would be constructed of stainless steel. The gate would be attached to a concrete foundation using stainless steel anchor bolts. A small building, about 400 square feet, would be built at the end of Dad’s Point on land directly adjacent to the closure structures. The building would be designed to store equipment required to operate the gate. As needed, a sheet pile floodwall would be constructed adjacent to the control structures to tie the structures into the adjacent levee or high ground areas. Construction would not require dredging or draglining.

1.3.9 Operation and Maintenance

Operation and maintenance (O&M) of the levees are the responsibility of the local maintaining agencies. Typical levee O&M includes the following actions:

- Vegetation maintenance up to four times a year by mowing or applying herbicide.
- Control of burrowing rodent activity monthly by baiting with pesticide.
- Slope repair, site-specific and as needed, by re-sloping and compacting.
- Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
- Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.
- Post-construction, groundwater levels would be monitored using the piezometers.

Following construction, the O&M manual for these reaches would be adjusted as needed. Under the adjusted O&M manual, large trees that are protected in place under the variance would be allowed to remain on the waterside slopes, but smaller shrubs would be removed and grasses would be regularly mowed to allow for inspection and access.

1.4 Types of Habitats Impacted

A variety of different habitat types occur within the study area that would be impacted by the LSJR study and would require mitigation to compensate for project impacts. The habitats include; giant garter snake (GGS) upland habitat, shaded riverine aquatic habitat, riparian communities, and valley elderberry longhorn beetle (VELB) habitat, Delta smelt shallow water habitat, open water habitat, and wetlands. These habitats are briefly described below.

1.4.1 Giant Garter Snake Upland Habitat

The GGS inhabits marshes, sloughs, ponds, small lakes, low gradient streams, other waterways and agricultural wetlands such as irrigation and drainage canals and rice fields, and the adjacent uplands. Essential habitat components consist of: (1) adequate water during the snake's active period, (early spring through mid-fall) to provide a prey base and cover; (2) emergent, herbaceous wetland vegetation, such as cattails and bulrushes, for escape cover and foraging habitat; (3) upland habitat for basking, cover, and retreat sites; and (4) higher elevation uplands for cover and refuge from flood waters.

1.4.2 Shaded Riverine Aquatic Habitat

Shaded Riverine Aquatic (SRA) habitat is defined as the near shore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of this valuable cover type include: (1) the adjacent bank being composed of natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water; and (2) the water containing variable amounts of woody debris, such as leaves, logs, branches and roots, as well as variable depths, velocities, and currents. SRA occurs throughout the study area along the riverbanks and levees and is contained within the other identified habitat types in these areas.

1.4.3 Riparian Communities

In general, riparian communities are among the richest community types, in terms of structural and biotic diversity, of any plant community found in California. Riparian vegetation provided important ecological functions, including: wildlife habitat; migratory corridor for wildlife; filters out pollutants and shades waterways, thereby improving water quality; provides connectivity between waterways and nearby uplands; provision of biomass (nutrients, insects, large woody debris, etc.) to adjacent waterways; and, in some situations, reduces the severity of floods by stabilizing riverbanks. Riparian forests and woodlands – even remnant patches – are important wildlife resources because they continue to be used by a large variety of wildlife species and because of their regional and statewide scarcity.

The overstory of the riparian habitat consists of mature, well-established trees, such as: Fremont cottonwood (*Populus fremontii*), valley oak (*Quercus lobata*), black willow (*Salix gooddingii*), and box elder (*Acer negundo var. californicum*). During the surveys, Oregon ash (*Fraxinus latifolia*), western sycamore (*Platanus racemosa*), and white alder (*Alnus rhombifolia*) were also observed. The midstory layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Elderberry shrubs (*Sambucus mexicana*), the host plant of the valley elderberry longhorn beetle

(*Desmocerus californicus dimorphus*), which is Federally listed as threatened, were observed in the riparian habitat along the San Joaquin River. The following habitat types are included in the Riparian community; however, they are referred to throughout this report as "riparian trees and shrubs". Additionally, shaded riverine aquatic (SRA) habitat is a member of the riparian community.

Riparian Woodland

Riparian woodlands in the project area include cottonwood riparian woodland, valley oak riparian woodland, walnut riparian woodland, and riparian scrub. Riparian habitats are considered to be among the most productive and diverse wildlife habitats in California. In addition to providing important nesting and foraging habitat, they function as wildlife movement corridors.

Larger remnant patches of Great Valley cottonwood riparian forest located within the project area are dominated by large Fremont cottonwood trees and Goodding's willow. Most of the otherwise linear or smaller patchy areas of this community lack Fremont cottonwood and are represented by Goodding's willow, red willow, arroyo willow, narrow leaved-willow, and scattered valley oak, Oregon ash, and buttonbush. Native ground cover species, mainly found in the larger remnant patches of riparian forest, include California blackberry and wild rose. Common nonnative understory species found in most elements include Himalayan blackberry and tree tobacco. Great Valley oak riparian forest is also located within the project area, occurring only on the landside of the levees.

1.4.4 Valley Elderberry Longhorn Beetle Habitat

The VELB is completely dependent on its host plant, elderberry (*Sambucus* spp.), which is a common component of the remaining riparian forests and adjacent upland habitats of California's Central Valley. These forests consist of several canopy layers with a dense undergrowth (Katibah, 1983). Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), willows (*Salix* spp.), and valley oak (*Quercus lobata*) are common upper canopy species. The midstory layer consists of smaller trees and shrubs; representative species observed were poison oak (*Toxicodendron diversilobum*), sandbar willow (*Salix exigua*), and California blackberry (*Rubus ursinus*). Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory.

1.4.5 Delta Smelt Shallow Water Habitat

Delta smelt are endemic to the Sacramento-San Joaquin estuary and are found seasonally in Suisun Bay and Suisun Marsh. Delta smelt are typically found in shallow water (less than 10 feet) where salinity ranges from 2 to 7 parts per thousand (ppt), although they have been observed at salinities between 0 and 18.4 ppt. Delta smelt occur in tidally influenced segments of the Sacramento and San Joaquin rivers, tributaries, and Delta. Delta smelt has the potential to occur in the waterways throughout the study area.

1.4.6 Open Water Habitat

Open water in the project area includes the San Joaquin River, Fourteenmile Slough, Fivemile Slough, Tenmile Slough, Smith Canal, French Camp Slough (perennial drainages), agricultural ditches (ditches), and small artificial ponds (ponds). Open water provides breeding, foraging, and migration habitat for numerous wildlife species. Mammal species commonly known to use perennial aquatic open water habitats include river otter, which uses these areas for foraging and escape cover, and muskrat, which may use deepwater areas as migration corridors between suitable foraging areas. Open water areas also provide essential foraging habitat for wading birds, including great blue heron, great egret, and snowy egret; numerous waterfowl species, including mallard, ruddy duck, and bufflehead; other water birds, including eared grebe, double-crested cormorants, and American white pelicans; and land birds, including black phoebe and belted kingfisher. These areas also provide rearing habitat, escape cover, and foraging habitat for reptiles and amphibians, including common garter snake, bullfrog, Pacific tree frog, and western toad. The vegetated areas below the ordinary high water mark provide nesting habitat for numerous songbirds, including red-winged blackbird and marsh wren, and wading birds such as Virginia rail.

1.4.7 Wetlands

"Wetlands" means areas that are inundated or saturated by surface or groundwater at a frequency and duration to support, and that under normal circumstances do support, a prevalence of vegetation typically adapted to life in saturated soil conditions. Wetlands generally include swamps, marshes, and bogs. For other water features such as rivers, streams, and ditches, the extent of potential Corps jurisdiction is determined by identification of the Ordinary High Water Mark, which is defined as "that line on shore established by the fluctuations of water and indicated by physical character of the soil, destruction of terrestrial vegetation, the presence of litter and debris, or other appropriate means that consider the characteristics of the surrounding areas" (33 CFR §328.3[e]).

1.5 Environmental Baseline

Historic native vegetation in the project area has been highly altered and fragmented as a result of flood risk management, land reclamation, urbanization, agriculture, and navigation projects. Flood risk management infrastructure in this area includes levees, river and tributary realignments, constructed channels, erosion protection, and control structures. Vegetation within the project area maintains some remnants of what was historically present, including Great Valley cottonwood riparian forest, Great Valley oak riparian forest, coastal and valley freshwater marsh. It also includes nonnative woodlands, agricultural (row crops, orchards and vineyards), and developed lands like lawns, parks and golf courses. Non-native grasses, forbs, shrubs, trees, and vines are interwoven throughout the landscape. Open water habitat includes rivers, tributaries, canals, and ditches. Ditches may contain water seasonally or year round.

Once, the San Joaquin River and tributaries were framed by dense riparian forest. Today, riparian vegetation consists of narrow linear strips and occasional patches of riparian forest and riparian scrub growing on or adjacent to the levee. Larger areas of riparian forest are present in some areas where the levee is set back from the river or tributary leaving floodplain on the waterside of the levee. More detailed description of the vegetation in the project area is provided below.

The northern portion of the project area includes Mosher Slough, Fivemile Slough, Fourteenmile Slough, Tenmile Slough, Stockton Deep Water Ship Channel. The central and southern part of the project area includes the San Joaquin River and its tributaries, including Calaveras River, Smith Canal, Mormon Slough, French Camp Slough and Duck Creek, the southern part of the project area is comprised of French Camp Slough and the San Joaquin River near the northern end of RD 17. The project area occurs within the Great Central Valley subdivision of the California floristic Province in San Joaquin County (Hickman, Ed. 1993:45). The topography of the portions of the project area adjacent to the levees is relatively level, and elevations in the project area range from less than 5 feet to approximately 38 feet above mean sea level. Throughout the project area, levee crowns are either paved or graveled for access and inspection and are generally devoid of vegetation.

Mosher Slough

Mosher Slough runs through a highly urbanized area. Woody riparian vegetation is most robust near the confluence with Fourteenmile Slough. It is comprised of typical Valley riparian trees and shrubs. Emergent wetland vegetation occurs intermittently at the water's edge. Landside vegetation includes non-native landscape trees and shrubs as well as natives. Typical wetland vegetation lines some stretches of this reach.

Fourteenmile Slough, Fivemile Slough, Tenmile Slough (Delta Front)

Waterward of the levees, some woody riparian trees and shrubs boarder these highly engineered waterways. Within some of the sloughs and canals, aquatic weeds cover much of the water surface. Along the edges of the waterways wetland vegetation is present intermittently. Within Fourteenmile Slough, intertidal vegetation is present on rocky substrate that is exposed during low tides. In Buckley Cove, near the confluence of Tenmile Slough with the Sacramento Deep Water Ship Channel, wetland and subtidal vegetation is present along with aquatic weeds. Landside vegetation is comprised mainly of row crops with some parcels in orchard.

San Joaquin River

On the San Joaquin River, lands waterside of the levees are very narrow and support a remnant riparian forest. Trees and shrubs occur in small patches or may be scattered individuals. Vegetation on the waterside of levee slopes in the project area is highly varied, ranging from ruderal herbaceous vegetation and annual grasses with few shrubs, to dense shrubs with little overstory, to mature riparian forest. Potential Shaded Riverine Aquatic (SRA) cover is found along much of the river in the project area.

Dominant waterside tree species include cottonwood, willow, oak, box elder, and black walnut. In the project area, common shrub species include willow, wild Rose, and blackberry. Elderberry shrubs are also present in some locations. Ruderal herbaceous vegetation is present on levee slopes. In some places the tree overstory along the levee is so dense that the leaf fall and shading, as well as human activity, precludes development of dense understory vegetation. At Does Reis road there is a park on both sides of the levee. Vegetation includes willows, weeping willow, cottonwood, fruitless mulberry, mesquite (thorns), elderberry, mistletoe.

Landside levee slopes are primarily barren or covered with ruderal vegetation. Beyond the base of the levees, riparian vegetation is rare but occasionally present in small isolated patches. Other trees include occasional single or isolated stands of native oaks and nonnative trees planted around farms, agricultural fields, and residential or other types of development. Larger remnant patches of Great Valley cottonwood riparian forest located within the study area are dominated by large Fremont cottonwood, trees and Goodding's willow (AECOM 2011). Most of the otherwise linear or smaller patchy areas of this community lack Fremont cottonwood and are represented by Gooding's willow, red willow, arroyo willow, narrow leaved-willow, and scattered valley oak, Oregon ash, and buttonbush (AECOM 2011). Native ground cover, mainly found in the larger remnant patches of riparian forest, include California blackberry and wild rose. Common nonnative understory species found in most elements include Himalayan blackberry and tree tobacco. Most of the Great Valley cottonwood riparian forest community could also be characterized as Great Valley riparian scrub, which does not include Fremont cottonwood and is characterized by a shorter canopy and more uniform structure; however, this habitat is part of the Great Valley cottonwood riparian forest that was extensive and connected along this entire reach of the San Joaquin River, and this document therefore describes all riparian habitat as such. (AECOM 2011)

Calaveras River

Levees and the lands adjacent to both the waterside and landside of the levees in the reach of the Calaveras River above, and just below, the Stockton Diverting Canal are largely devoid of trees and shrubs. The exception is some orchards landward of the north levee. Moving downstream, more trees and shrubs are present on and adjacent to the levees. In the highly urbanized reaches, many of the landside trees and shrubs are associated with landscape plantings in yards, parks, and public rights of way. Wetland vegetation appears to line the channel in places.

Smith Canal

Smith Canal is surrounded by urban residential areas, including hard-scaping (sidewalks) and some landscape plantings adjacent to the water's edge. Near the confluence of the canal with the San Joaquin River, there is a public park, including a picnic area, boat launch ramp and associated infrastructure. There is an irrigated lawn and a mixture of native and non-native trees and shrubs. Wetland vegetation is prevalent at the water's edge and non-native invasive water plants inhabit the "bay" near the boat launch ramp. Invasive waterweeds occupy much of the inlet in the vicinity of the boat launch ramp.

French Camp Slough and Duck Creek

Levees along Duck Creek are clear of trees and shrubs. Adjacent lands are largely in agriculture with urban development beginning to extend into these lands. French Camp Slough upstream of the confluence with Duck Creek is very similar in character to Duck Creek. Levees are free of trees and shrubs and adjacent lands are in agriculture with urban lands extending towards the levee slough.

The lower reaches of French Camp Slough (between Duck Creek and the San Joaquin River) are surrounded landward by urban development. The Weston Ranch residential development is immediately to the south in the northern portion of RD 17. A municipal golf course extends adjacent to the northern bank/levee of French Camp Slough in Central Stockton. Between the north and south French Camp Slough levees is an "island" of land that is in agriculture. The perimeter of this island contains a fairly thick margin of trees and shrubs.

In the lower French Camp Slough reach, the levee crown includes a paved road. The landside levee slope and toe are mostly devoid of vegetation. There are some annual grasses and herbs. These are largely non-native weedy plants. Where trees and shrubs are present within the landside easement, they are mainly landscape plantings associated with public rights of way and private yards. The waterside levee slope and easement have trees and shrubs throughout their length, being quite dense in some areas. Trees include native valley oak, box elder, cottonwood, black walnut, and willows. Elderberry shrubs, poison oak, patches of dead willow shrubs, and snags are present. In the canal between the RD 17 levee and the mid-channel island to the north, wetland plants are abundant. These include tules, nut sedges, and tule potato. Non-native English walnut trees, water hyacinth, and mistletoe are also present.

1.6 Potential Project Impacts

During PED the levees will undergo intensive engineering evaluation to determine their suitability for a variance to Engineer Technical Letter (ETL) 1110-2-583. A vegetation variance request requires the Corps to show that the safety, structural integrity, and functionality of the levee would be retained if the vegetation were to remain in place. Based upon the information available at this time, and using engineering judgment, it is estimated that 50% of the existing vegetation on the lower waterside slope and within the waterside easement may be allowed to remain and almost none of the vegetation on the landside levee slope or within the landside easement would be allowed to remain. A vegetation variance would reduce adverse project impacts on vegetation and wildlife since without a variance, all woody vegetation would be removed. In addition, existing infestations of invasive weeds has an influence on hydraulic roughness during high-flow events, decreases the capacity of the floodway, and adversely affects bank erosion and sedimentation processes. The Corps would remove the noxious weeds from the various plant communities prior to construction. However, even with the reduced impacts provided by the vegetation variance and the benefits of noxious weed removal efforts, vegetation impacts throughout the project area would occur in the proposed construction footprint.

For this region, impacts to better quality habitat have a much greater effect on ecosystem function because of the degree of degradation and fragmentation present within the system. In many cases the proposed project would be removing the only habitat available for long stretches of the waterways, and proposes compensating for this habitat off site. Permanent removal of this higher quality habitat would also result in the loss of other services that riparian vegetation provides, including:

- An essential food source for fish and wildlife, including threatened and endangered species;
- Aquatic resting and refugia for resident and migratory fish species;
- Large woody debris recruitment;
- Nesting and rearing habitat for terrestrial wildlife species;
- Nutrients for the ecological system;
- Shade for the river which maintains water temperatures and dissolved oxygen concentrations; and,
- Increased habitat value for VELB.

Additionally, habitat in the lower quality areas may not require as much mitigation, or in some cases no mitigation could be justified at all. For the Recommended Plan, The estimated impacts for the habitats discussed above and special-status species impacts as established in the BOs are shown below in Table 2. The total number of acres affected would be refined during the design phase.

The listed habitat types represent all estimated habitat impacts associated with the project, with the exception of agricultural fields. Agricultural impacts are not included because they are addressed under the project's Real Estate Plan and are not addressed further in this HMMAMP. The habitat types listed in Table 2 are components of habitat for special status species listed under the Federal Endangered Species Act (16 U.S.C. 1531 *et seq.*), and are required compensation established in the USFWS and NMFS Biological Opinions, with the exception of wetland, grassland, and riparian habitat impacts.

Table 2. Habitat Impacts for the LSJR Study Recommended Plan

	GGS Upland[1] (acres)	GGS Aquatic[1] (acres)	Riparian (acres)	SRA Habitat[1] (linear feet)	Elderberry Shrubs[1]	Delta Smelt Shallow Water[1] (acres)	Delta Smelt Open Water[1] (acres)	Wetland (acres)	Grassland (acres)
Mosher Slough		0	21.5	0		0	0	3	
Delta Front		0.5	30.75	0		123	1	4	
Calaveras River		0	52	7,804		0	0	1.75	
San Joaquin River		0	17	6,317		0	1	0	
French Camp Slough		0	15.75	5,509		0	0	0	
Duck Creek		0	2	0		0	0	2	
TOTAL	Permanent 35.12[2] acres Temporary 111.5 acres	Permanent 0.5 acres Temporary 6 acres	139	19,630	44 Shrubs/ 96 stems[3]	123	2	10.75	8.87[4]

[1] Endangered Species Act Compensation per USFWS and NMFS Biological Opinions. See EIS or BO for effects analysis.
[2]Impacts are at Fourteenmile Slough and Duck Creek
[3]Impacts are at Fourteenmile Slough, Calaveras River, and San Joaquin River
[4]Impacts are at Mosher Slough and Delta Front

In order to determine the appropriate level of mitigation for habitat mitigation (wetlands and riparian habitat impacts), a habitat evaluation and cost effectiveness/incremental cost analysis (CE/ICA) were conducted. The habitat evaluation quantifies the relative value and change in value of the habitat impacted by the project, and the CE/ICA evaluates mitigation alternatives to determine the most cost effective plan for the Government. These evaluations are described in Section 1.7 below. It should be noted that during the design phase, HEPs will be conducted on smaller reaches to account for and better quantify variations in habitat quality throughout the project area, and to ensure that the mitigation is applied appropriately throughout the project area.

1.7 Habitat Evaluation

For the purposes of evaluating the impacts of the LSJR study Recommended Plan on fish and wildlife resources in the project area, and in the spirit of SMART Planning, a Habitat Evaluation Procedures (HEP) was produced with a reliance on existing photographic and aerial imagery to establish a reference baseline for the habitat conditions in the study area. The HEP provided information for two general types of wildlife habitat comparisons: 1) the relative value of different areas at the same point in time; and 2) the relative value of the same areas at future points in time. By combining the two types of comparisons, the impacts of proposed project on riparian, wetland, and grassland habitats were quantified and compensation needs (in terms of acreage) for the project were determined.

The assumption that habitat for selected wildlife species or communities can be numerically described by a model produces a Habitat Suitability Index (HSI). The HSI, a value from 0.0 to 1.0, provides a measure of habitat quality for a sample area in terms of suitability for the particular species or community being evaluated. A combination of three Corps Ecosystem Planning Center of Expertise approved "blue book" HSI models were used to best approximate the different habitat types in the study area:

- The yellow warbler HSI model (USFWS 1982) was applied to shrubby riparian and wetland habitats;
- The black shouldered kite HSI model (USFWS 1987) was applied to grassland habitat; and,
- The mink HSI model (USFWS 1986) was applied to woody riparian habitat.

Table 3 describes the habitat variables established within each HSI model, and how the data was collected for these variables. For the LSJR study Recommended Plan, data was estimated visually and using Google Earth.

Table 3. HSI Models, Variables, and Data Collection Methods.

HSI Model and Cover-Type	HSI Model Variables	Data Collection Method
Yellow Warbler Shrubby Riparian Habitat Wetlands and Waters of the U.S.	V1 - % shrub crown cover	Visual and aerial photo estimation
	V2 - Average height of shrub canopy	Visual and aerial photo estimation
	V3 - % of hydrophytic shrub canopy	Visual and aerial photo estimation
Black Shouldered Kite Grasslands	V1 - % of tall grasslands	Visual and aerial photo estimation
	V2 - % of short grasslands	Visual and aerial photo estimation
	V3 - % of rush	Visual and aerial photo estimation
	V4 - % of salt marsh	Visual and aerial photo estimation
Mink Woody Riparian Habitat	V1 - % canopy cover within 100m of waters edge	Visual and aerial photo estimation
	V2 - % shoreline cover within 1m of water's edge	Visual and aerial photo estimation

1.7.1 HEP Project Impact Assessment

For the purposes of this HEP, each waterway in the study area was evaluated to determine the most prominent habitat types on that waterway. In order to account for variations in habitat quality, the riparian habitat was split into shrubby riparian habitat versus woody riparian habitat; waterways with more mature, woody vegetation were evaluated by the Mink model, while waterways with more shrubby vegetation were evaluated using the yellow warbler model. Table 4 displays the acreages of each habitat type by HSI model. Some of the waterways (Delta Front and Mosher Slough; French Camp Slough and Duck Creek) were combined together from the acreages displayed in Table 2 for the purposes of this analysis.

Table 4. Acreages of Habitat Types in the LSJR Study Area.

Waterway	Shrubby Riparian Habitat (Yellow Warbler)	Wetlands and Waters of the U.S. (Yellow Warbler)	Woody Riparian Habitat (Mink)	Grassland (Black Shouldered Kite)
Mosher Slough, Delta Front	52.25	7	0	8.87
Calaveras River	0	1.75	52	0
San Joaquin River	0	0	17	0
French Camp Slough & Duck Creek	17.75	2	0	0
Total	70	10.75	69	8.87

The quantity part of the formula is any measure of area which is appropriately sized for the study. The product of these two measures is comparable to "habitat value" which equals habitat quantity multiplied by habitat quality. This formula is expressed as a Habitat Unit (HU). The Average Annual Habitat Units (AAHUs) over the period of analysis can then be calculated and used to determine mitigation needs.

Habitat Quantity (acres) x Habitat Quality (HSI) = Habitat Value Unit

Since it is not possible to empirically determine habitat quality and quantity for future years, future HSI values were projected. Four Target Years (TY) were projected over the period of analysis:

- TY0 is the baseline condition prior to impacts/mitigation implementation.
- TY1 is one year following the impact/mitigation implementation.
- TY25 is 25 years following the impact/mitigation implementation.
- TY50 is 50 years following the impact/mitigation implementation, and is considered the end of the period of analysis.

The future HSI values were projected by increasing or decreasing specific baseline variables and/or HSI values for each evaluation element for the three HSI models based on best professional knowledge of performance at other mitigation sites, literature on plant growth, and conditions at reference sites. To predict changes in the HSI for each future scenario, it was necessary to make assumptions regarding baseline and future values within project impact and compensation areas. The assumptions made for each HSI model for the LSJR study area without project can be seen in Tables 5 to 7 below.

Table 5. HSI Variables for the Black Shouldered Kite Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT									
Time	**Variables**				**Suitability Index**				**Output**
	V1	**V2**	**V3**	**V4**	**SI-V1**	**SI-V2**	**SI-V3**	**SI-V4**	**HSI**
TY0	10%	65%	25%	0%	1	.5	.3	.25	.5
TY1	10%	65%	25%	0%	1	.5	.3	.25	.5
TY25	10%	65%	25%	0%	1	.5	.3	.25	.5
TY50	10%	65%	25%	0%	1	.5	.3	.25	.5
HSI = 1(V1) + .5(V2) + .3(V3) + .25(V4)									

Table 6. HSI Variables for the Yellow Warbler Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	60%	3	40%	1	1	.5	.83
TY1	60%	3	40%	1	1	.5	.83
TY25	60%	4	40%	1	1	.5	.83
TY50	60%	4.5	40%	1	1	.5	.83
HSI = (V1*V2*V3)^1/3							

Table 7. HSI Variables for the Mink Model Without-Project Based on Habitat Values.

HEP - FUTURE WITHOUT PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	
TY0	40%	60%	.4	.6	.5
TY1	40%	60%	.4	.6	.5
TY25	45%	65%	.45	.65	.55
TY50	50%	70%	.5	.7	.6
HSI = (SIV1*SIV2)^1/2					

The without project condition tables (Tables 5 to 7 above) on average show medium existing habitat quality for grassland and woody riparian habitat (0.50 and 0.54 respectively) while shrubby riparian habitat quality was relatively high at 0.83. However, there is substantial variability in habitat quality along each waterway within the project area. For the purposes of this habitat evaluation, an average overall habitat value was calculated for each waterway.

The assumptions for each HSI model for the LSJR study with project impacts can be seen in Tables 8 to 10 below.

Table 8. HSI Variables for the Black Shouldered Kite Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT									
Time	**Variables**				**Suitability Index**				**Output**
	V1	**V2**	**V3**	**V4**	**SI-V1**	**SI-V2**	**SI-V3**	**SI-V4**	**HSI**
TY0	8%	67%	25%	0%	1	.5	.3	.25	.49
TY1	8%	67%	25%	0%	1	.5	.3	.25	.49
TY25	10%	65%	25%	0%	1	.5	.3	.25	.5
TY50	10%	65%	25%	0%	1	.5	.3	.25	.5
HSI = 1(V1) + .5(V2) + .3(V3) + .25(V4)									

Table 9. HSI Variables for the Yellow Warbler Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	30%	2	30%	.5	1	.38	.62
TY1	35%	2.5	30%	.55	1	.38	.64
TY25	50%	4	38%	.8	1	.44	.75
TY50	60%	4.5	40%	1	1	.5	.83
HSI = (V1*V2*V3)^1/3							

Table 10. HSI Variables for the Mink Model With-Project Based on Habitat Values.

HEP - FUTURE WITH-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	25%	45%	.25	.45	.35
TY1	25%	50%	.25	.5	.375
TY25	40%	60%	.4	.6	.5
TY50	50%	70%	.5	.7	.6
HSI = (SIV5*SIV6)^1/2					

The with project condition tables (Tables 8 to 10 above) on average show a reduction in habitat quality for all habitats in the study area following project construction. Tables 11 through 14 below applies the HSI values from the tables above to each habitat type with the resulting habitat units (HUs) under the with and without project conditions.

Table 11. Target Year Habitat Conditions for Shrubby Riparian Habitat.

Condition	**Target Year**	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	70	.62	43.4
	TY 1	0	0	0
	TY 25	35	.75	26.25
	TY 50	50	.83	41.5
Without Project Condition	TY 0	70	.83	58.1
	TY 1	70	.83	58.1
	TY 25	70	.83	58.1
	TY 50	70	.83	58.1

Table 12. Target Year Habitat Conditions for Wetlands.

Condition	**Target Year**	**Acres**	**HSI Value**	**Total Habitat Units**
With Project Condition	TY 0	10.75	.62	6.66
	TY 1	0	0	0
	TY 25	1.5	.75	1.12
	TY 50	3	.83	2.49
Without Project Condition	TY 0	10.75	.83	8.92
	TY 1	10.75	.83	8.92
	TY 25	10.75	.83	8.92
	TY 50	10.75	.83	8.92

Table 13. Target Year Habitat Conditions for Woody Riparian Habitat.

Condition	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	69	.35	24.15
	TY 1	0	0	0
	TY 25	0	0	0
	TY 50	0	0	0
Without Project Condition	TY 0	69	.5	34.5
	TY 1	69	.5	34.5
	TY 25	69	.55	37.95
	TY 50	69	.6	41.4

Table 14. Target Year Habitat Conditions for Grassland.

Condition	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	8.87	.49	4.35
	TY 1			

50The net impact represents the total estimated value for the impacted acreage in the study area.

Table 15. HEP Results – Net Project Impacts.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian	Grassland
AAHUs With Project	23.67	1.24	0.24	24.67
AAHUs Without Project	58.1	8.92	37.91	4.43
Net Impact (AAHUs)	-34.43	-7.68	-37.67	+20.24

The HEP results in Table 15 show a net benefit to grasslands within the project area. This is primarily because the negative impacts to riparian habitat result in a transition of levee slope habitat within the project area from riparian habitat to grassland. Since there would be an increase in grassland acreages within the project area, and the costs for reseeding the levee slopes are a construction cost rather than a mitigation cost, grasslands will not be discussed further in this habitat assessment. However, the monitoring requirements for GGS Upland habitat, which consists of grasslands within 200 feet of GGS Aquatic habitat, are discussed in Section 2.1 below.

1.7.2 HEP Mitigation Site Assessment

In order to determine the appropriate quantities of mitigation justified for the LSJR Study, an assessment was conducted to assess the value of the habitat available from a mitigation bank and habitat created at a potential nearby offsite mitigation area. For the purposes of project planning, it is assumed that credits would be purchased from the Cosumnes Floodplain Mitigation Bank. Credits are currently available at the Cosumnes Floodplain Mitigation Bank in the quantities needed for project impacts, and the impacts are within the approved service area of the bank. Based on the California Department of Fish and Game's (CDFG) Report to the Legislature on California Wetland Mitigation Banking (CDFG 2012), it was reported that there is a total of 471.71 total acres of habitat at the Cosumnes Floodplain Mitigation Bank, which equates to 458.74 total credits available. Based on the estimates in the CDFG report, it is assumed that the habitat at the bank has a baseline HSI value of 0.97. Tables 16 through 18 below project the change in HSI value at the mitigation bank over the period of analysis and calculates the total HUs for the target years during the period of analysis.

The acreage displayed in Tables 16 through 18 were calculated by running the HEP on a variety of scenarios in order to come up with a solution that was equivalent to the impact in AAHUs. Only the equivalent results are shown below.

Table 16. Target Year Habitat Conditions for Shrubby Riparian Habitat at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	34.88	.97	33.83
TY 1	34.88	.97	33.83
TY 25	34.88	.99	34.53
TY 50	34.88	1.0	34.88

Table 17. Target Year Habitat Conditions for Wetlands at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	7.78	.97	7.55
TY 1	7.78	.97	7.55
TY 25	7.78	.99	7.70
TY 50	7.78	1.0	7.78

Table 18. Target Year Habitat Conditions for Woody Riparian Habitat at Bank.

Target Year	Acres	HSI Value	Total Habitat Units
TY 0	38.16	.97	37.01
TY 1	38.16	.97	37.01
TY 25	38.16	.99	37.77
TY 50	38.16	1.0	38.16

The total AAHUs for the mitigation bank are shown in Table 19 below. The results in Table 19 demonstrate that the project impact in AAHUs would be fully mitigated through the purchase of 34.43 mitigation bank credits of shrubby riparian habitat (riparian floodplain habitat at the bank), 7.68 credits of wetland habitat, and 37.67 credits of woody riparian habitat (riparian forest habitat at the bank).

Table 19. HEP Results – Mitigation Bank.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian
AAHUs	34.43	7.68	37.67
*Net Impact**	-34.43	-7.68	-37.67

* Net impact as displayed in Table 17

Additionally, a HEP was conducted on a potential off-site mitigation site to determine the cost effectiveness of different mitigation alternatives. The off-site mitigation site was assumed to be located within the Delta Front region of the project area on the landside of the levees with a baseline condition of fallow farm fields. There are multiple properties in this portion of the study area that include these characteristics. If this mitigation alternative is selected, real estate negotiation would occur to determine the specific location of the off-site mitigation area. Tables 20 and 21 display the projected HSI calculations for the future without project condition of the potential mitigation site.

Table 20. HSI Variables for the Yellow Warbler Without Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITHOUT-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	15%	1	0%	0.2	0.5	.1	0.22
TY1	15%	1	0%	0.2	0.5	0.1	0.22
TY25	15%	1	0%	0.2	0.5	0.1	0.22
TY50	15%	1	0%	0.2	0.5	0.1	0.22
HSI = (V1*V2*V3)^1/3						Average	0.22

Table 21. HSI Variables for the Mink Without Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITHOUT-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	15%	5%	.25	.05	0.11
TY1	15%	5%	.25	.05	0.11
TY25	15%	5%	.25	.05	0.11
TY50	15%	5%	.25	.05	0.11
HSI = (SIV5*SIV6)^1/2					

Tables 22 and 23 display the projected HSI calculations for the mitigation site projected for the period of analysis.

Table 22. HSI Variables for the Yellow Warbler With Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITH-PROJECT							
Time	**Variables**			**Suitability Index**			**Output**
	V1	**V2**	**V3**	**SI-V1**	**SI-V2**	**SI-V3**	**HSI**
TY0	15%	1	0%	.2	0.5	.1	0.22
TY1	20%	1.5	15%	.25	0.8	.2	0.34
TY25	60%	4	40%	.85	1	.45	0.73
TY50	65%	4.5	45%	.9	1	.5	0.77
HSI = (V1*V2*V3)^1/3							

Table 23. HSI Variables for the Mink With Project Based on Habitat Values for Off-Site Mitigation.

HEP - FUTURE WITH-PROJECT					
Time	**Variables**		**Suitability Index**		**Output**
	V1	**V2**	**SI-V1**	**SI-V2**	**HSI**
TY0	15%	5%	.25	.05	0.11
TY1	20%	10%	.3	.1	0.17
TY25	65%	65%	.8	.6	0.69
TY50	75%	75%	1.0	.7	0.84
HSI = (SIV5*SIV6)^1/2					

Tables 24 through 26 below projects the change in HSI value for the mitigation site over the period of analysis and calculates the total HUs for the target years during the period of analysis.

Table 24. Target Year Habitat Conditions for Shrubby Riparian Habitat for Off-Site Mitigation.

	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	82.48	0.22	18.14
	TY 1	82.48	0.34	28.04
	TY 25	82.48	0.73	60.21
	TY 50	82.48	0.77	63.51
Without Project Condition	TY 0	82.48	0.22	18.14
	TY 1	82.48	0.22	18.14
	TY 25	82.48	0.22	18.14
	TY 50	82.48	0.22	18.14

Table 25. Target Year Habitat Conditions for Wetlands for Off-Site Mitigation.

	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	18.37	0.22	4.04
	TY 1	18.37	0.34	6.24
	TY 25	18.37	0.73	13.41
	TY 50	18.37	0.77	14.14
Without Project Condition	TY 0	18.37	0.22	4.04
	TY 1	18.37	0.22	4.04
	TY 25	18.37	0.22	4.04
	TY 50	18.37	0.22	4.04

Table 26. Target Year Habitat Conditions for Woody Riparian Habitat for Off-Site Mitigation.

	Target Year	Acres	HSI Value	Total Habitat Units
With Project Condition	TY 0	78.18	0.11	8.60
	TY 1	78.18	0.17	13.29
	TY 25	78.18	0.69	53.94
	TY 50	78.18	0.84	65.67
Without Project Condition	TY 0	78.18	0.11	8.60
	TY 1	78.18	0.11	8.60
	TY 25	78.18	0.11	8.60
	TY 50	78.18	0.11	8.60

The total AAHUs with and without project for the mitigation site are shown in Table 27 below. Table 27 shows that the project impacts would be fully mitigated through the off site creation of 52.57 acres of shrubby riparian habitat, 11.71 acres of wetland habitat, and 46.26 acres of woody riparian habitat.

Table 27. HEP Results – Off-Site Mitigation Creation.

	Shrubby Riparian	Wetlands and Waters of the U.S.	Woody Riparian
AAHUs With Project	52.57	11.71	46.26
AAHUs Without Project	18.14	4.04	8.60
Net Habitat Increase	34.43	7.67	37.66
Net Impact (AAHUs)*	*-34.43*	*-7.68*	*-37.67*

* Net impact as displayed in Table 17

1.7.3 Cost Effectiveness/Incremental Cost Analysis

To determine whether the proposed mitigation amounts were cost effective, a Cost Effectiveness/Incremental Cost Analysis (CE/ICA) was conducted on habitat mitigation that is not associated with threatened and endangered species, which includes the riparian and wetland impacts described in Table 2 above. The CE/ICA report is included with this document as Appendix A. The HEP results shown in Tables 15, 19, and 27 above were incorporated into the CE/ICA.

The cost for off-site mitigation site creation and mitigation bank credits were calculated to replace the value of the impacted habitat in AAHUs in kind. The total cost of the mitigation implementation was then annualized, and the CE/ICA was conducted using the Corps certified IWR Plan to analyze the AAHUs and annual cost of each habitat type under the mitigation bank and off-site mitigation scenarios.

IWR Plan generated 27 alternatives using different combinations of the six increments of mitigation inputted into the model. The CE/ICA determined that four of these alternatives were the Government's Best Buy alternatives. These four alternatives included:

- No action;
- Implementing only woody riparian mitigation at a mitigation bank;
- Implementing only woody riparian and shrubby riparian mitigation at a mitigation bank; and,
- Implementing all three habitats at a mitigation bank.

All three off-site mitigation site creation alternatives were found to not be cost effective for the Government. This was primarily due to the increased costs associated with the acquisition of real estate to create the off-site mitigation area.

The LSJR Study proposes to mitigate for impacts to shrubby riparian, woody riparian, and wetland habitats through the purchase of credits at a mitigation bank to replace the value of the habitat lost in kind, as displayed in the above HEP analysis. The proposed habitat mitigation described above was determined to be justified, based on the significance of the riparian and wetland habitat resources being impacted by the proposed project, and the results of the CE/ICA.

1.8 Proposed Mitigation Measures

The preparation of mitigation plans, including objectives, plan design, determination of success criteria, and monitoring needs would be coordinated with Federal and State resource agencies to the greatest extent practicable. Mitigation objectives are specific actions to be taken to avoid and minimize adverse affects, such as best management practices, compliance with Federal and State regulatory laws, and environmental commitments. Mitigation objectives include the identification of specific amounts of mitigation justified to compensate for remaining unavoidable losses.

Items below present a summary of environmental commitments that the Corps would implement as part of the LSJR study Recommended Plan to mitigate by avoiding and minimizing impacts and to meet the requirements, terms and conditions specified in the BOs.

- During PED, the Corps Sacramento District will conduct appropriate engineering investigations to determine the suitability of Recommended Plan levees for a variance to ETL 1110-2-583 in order to retain some woody vegetation on the lower waterside levee slope and within the waterside easement. All woody vegetation would be removed from the landside levee slopes and easement. It is estimated that 50% of the existing woody vegetation on the lower waterside slope and within the waterside easement may be allowed to remain. This estimate serves as the basis for the Section 7 ESA consultations and BOs. The variance approval process is in alignment with the Corps' Levee Safety Program's goal of maintaining public safety as the primary objective and assuring application of consistent and well documented approaches. Disturbance or removal of trees or larger woody vegetation would be replaced with native riparian species, outside of the vegetation free zone, as established in the ETL.
- Vegetation removal, particularly tree removal, would be conducted between September 16 and January 31, to the extent feasible, to minimize potential loss of active bird nests and bat maternity roosts.
- Construction would be scheduled when listed terrestrial and aquatic species would be least likely to occur in the project area, approximately May or June through October, depending on the species present on a site-specific basis. If construction needs to extend into the timeframe that species are present, the Corps would coordinate with the resource agencies.

In addition to the mitigation measures described above, the Corps would implement compensatory mitigation for the impacts to ESA species shown in Table 2. The mitigation acreages for LSJR study were calculated using a combination of site surveys and aerial photography from Google Earth to determine where the project footprint impacted different habitat types. The habitat types for ESA compensatory mitigation include: SRA, GGS, VELB, and Delta smelt shallow and open water.

Table 28. Proposed Mitigation for the Recommended Plan.

Habitat Type	Potential Impacts	Duration of Impact	Mitigation/ Compensation (Acres/Linear Feet)	Mitigation Cost
GGS Upland GGS Aquatic	111.5 Acres 6 Acres	Single Construction Season	111.5 acres site restoration 6 acres site restoration	Hydroseeding/ Relocation of drains – Construction Cost
GGS Upland GGS Aquatic	12.5 Acres 0.5 Acres	Permanent	35.12 acres bank credit 1.5 acres bank credit	$2,107,200 $90,000
Riparian	139 Acres	Permanent	72.13 bank credits	$5,409,750
Shaded Riverine Aquatic Habitat (ESA Fish Species)	19,630 LF	Permanent	58,890 bank credits	$5,594,550
Shallow Water Habitat (ESA Fish Species)	234 Acres	During operation of closure structure	123 acres bank credit	$15,990,000
Elderberry Shrubs	41 Shrubs/ 96 stems	Permanent	14 Acres created onsite, plus monitoring and adaptive management[1]	$2,292,000[3]
Open Water	4 Acres	Temporary	2 acres bank credits	$260,000
Wetlands	10.75 Acres	Permanent	7.68 bank credits	$998,400
			Total	**$32,742,000**
			Total w/ Contingency [2]	**$45,184,000**

[1] Monitoring and adaptive management costs are detailed in Chapter 3 of this HMMAMP.
[2] As displayed in Total Project Cost Summary
[3]Elderberry mitigation includes real estate acquisition for 14 acres at $18,000 per acre

Table 28 describes the types and amounts of habitat that would be potentially impacted by the project, the duration of the impacts, the amount of mitigation in total acreage per the USFWS and NMFS BOs and the recommendations of the USFWS Coordination Act Report, and projected costs as estimated according to existing mitigation prices. Currently, permanent impacts to GGS uplands and aquatic habitat, riparian, SRA, Delta smelt shallow water, open water, and wetland habitats are proposed to occur at a mitigation bank. Valley elderberry longhorn beetle mitigation is proposed to occur on site, as well as restoration of single season temporary impacts to GGS habitats. Further details of the costs per acre for each habitat type are included in Appendix A.

Restoration of GGS upland habitat for single season temporary impacts includes hydroseeding of disturbed soil surfaces such as levee slopes to prevent erosion and restore upland habitat for giant garter snake. USFWS recommends a mix of at least 20 to 40 percent native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.); 2 to 10 percent native forbs; 5 percent rose clover (*Trifolium hirtum*); and 5 percent alfalfa (*Medicago sativa*). Approximately 40 to 68 percent of the mixture may be non-aggressive European annual grasses such as wild oats (*Avena sativa*), wheat (*Triticum* ssp.), and barley (*Hordeum vulgare*). The Corps will not include aggressive non-native grasses, such as perennial ryegrass (*Lolium perenne*), cheatgrass (*Bromus tectorum*), fescue (*Festuca* spp.), giant reed (*Arundo donax*), medusa-head (*Taeniatherum caput-medusae*), or Pampas grass (*Cortaderia selloana*) in the hydroseed mix (USFWS 1997).

1.9 Location of Mitigation and Compensation Sites

WRDA 2007 Section 2036(c) directs the Corps to, where appropriate, first consider the use of an approved mitigation bank to compensate for wetland impacts. Credits for additional habitat types, including riparian zones, is also permitted, if credits are available and the use of them is deemed appropriate. As discussed above, the Corps proposes to purchase credits at a local mitigation bank for permanent impacts to GGS uplands and aquatic habitat, riparian, SRA, Delta smelt shallow water, open water, and wetland habitats. As a result, the mitigation bank would be responsible for all site establishment, monitoring, adaptive management measures, and for achieving mitigation success. Therefore, this mitigation plan addresses only the habitat types currently proposed for habitat creation: valley elderberry longhorn beetle habitat and its associated riparian habitat, and restoration of onsite temporary impacts to GGS upland habitat.

The proposed mitigation site for VELB and associated riparian habitats is a 14 acre site along Fourteenmile Slough. This site consists of the acreage created by the proposed levee setback. Proposed plantings for this site would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), and valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus* spp.), redbud (*Cercis canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Since this mitigation site is associated with ESA mitigation for the Federally-threatened VELB, it is not included in the above HEP analysis. However, since it will be habitat created and monitored by USACE, it is evaluated in the Monitoring and Adaptive Management sections of this HMMAMP below.

The Corps is committed to implementing project conservation and mitigation as detailed in the BOs, however site selection and real estate coordination has not occurred at this time for onsite and offsite mitigation and would be determined during the design phase of the project. This HMMAMP will accompany the final EIS/EIR, and will be updated throughout the design phase as detailed design efforts allow for finalizing the mitigation plans. The HMMAMP will be coordinated with USFWS and NMFS during the design phase per the terms and conditions of the Biological Opinions and updated as needed.

1.10 Compensation Timing

Compensation timing refers to the time between the initiation of construction at a particular site and the attainment of the habitat benefits to targeted species from designated compensation sites. For example, compensation time would be the time required for on-site plantings to provide significant amounts of shade or structural complexity from instream woody material recruitment to provide habitat for fish species. Significant long-term benefits have often been considered as appropriate to offset small short-term losses in habitat for listed species in the past, as long as the overall action contributes to recovery of the listed species. The authority to compensate prior to or concurrent with project construction is given under WRDA 1986 (33 United States Code [USC] § 2283). Additionally, ER 1105-2-100, Appendix C states that authorized ecological resource mitigation activities and features should occur before construction of the project, concurrent with the acquisition of lands, or concurrent with the physical construction of the project.

2.0 MITIGATION AND MONITORING STRATEGY

The purpose of this HMMAMP is to present conceptual mitigation proposals, establish performance standards, and outline adaptive management tasks and costs. Conceptual mitigation proposals are based on the habitat impacts described above. Performance standards are established below for each habitat type, and monitoring would be conducted with the intent of meeting those standards. Over the 3 to 5 year site establishment period, improvements in field and analytic techniques may lead to changes in the monitoring methodology. While this vegetation and habitat monitoring methodology protocol builds on past years' experiences, it is likely that other opportunities for improvement will be identified in the future that should be incorporated into the protocol. In the future, there may be a determination that specific performance standards have been met and that associated monitoring tasks could cease. Similarly, it could be determined that a monitoring task was not returning useful information, and therefore not worth the expense of continuation.

Monitoring must be closely integrated with the adaptive management. The application of adaptive management principles to mitigation projects by modifying mitigation objectives during the monitoring period is a reasonable and foreseeable alternative. Unrealistic expectations or inaccurate assumptions can lead to the establishment of inappropriate project objectives. It is possible that a decision to modify success criteria might be reached based on results after several years of monitoring. In addition to modifying project objectives, there is a potential for changes to or adaptation of management actions based on monitoring results. The purpose of adaptive management is to enable strategic changes to improve the mitigation sites to functioning habitat.

Vegetation and habitat variable monitoring and data collection would occur by a qualified biologist, botanist, or habitat restoration specialist using the protocol described below and shown in Table 29 to determine the success of riparian revegetation plantings and overall habitat development. In accordance with WRDA 2007 Section 2036(a), monitoring shall continue until it has been demonstrated that the mitigation has met the ecological success criteria, as documented by the District Engineer and determined by the Division Commander.

Table 29. Summary of On-site Habitat Types and Monitoring Recommendations.

Habitat	Monitoring Variable	Method to be Used	Spacing/number of Samples	Data to be Collected	Success Criteria
GGS Upland	Total Herbaceous Species Cover	Visual estimates of cover within 1 square meter (m^2) sampling quadrats	One quadrat randomly located in each planting zone	Herbaceous species composition, total cover, and observation of GGS	Meeting 75% native species present and 95% overall cover onsite within 1 year
Riparian Habitat	Vegetation Species Cover (Ground, Midstory, and Canopy)	Line-intercept estimates of ground and overhead canopy cover with visual estimates of vigor	Monitoring transects; number of transects and spacing dependent on site length	Woody species composition, growth, and natural recruitment	75% vegetative cover after 5 years
Elderberry	Elderberry and Native Vegetation Health and Vigor, survival of elderberry shrubs (VELB habitat)	Visual assessment of vegetation health and vigor; census of VELB and exit holes	Total census of elderberry shrubs and native vegetation, census of VELB and exit holes	Total survival of elderberry and native vegetation, census of VELB and exit holes	Survivability of 60% of shrubs*

*60% survivability is the established survival criteria for elderberry shrubs in the USFWS Conservation Guidelines for the Valley Elderberry Longhorn Beetle (1999)

The project's compensation objective is to directly mitigate for the loss of habitat value and function that results from construction impacts. This plan focuses on establishing successful and diverse habitats that provide an ecological value consistent with mature existing habitat conditions in the study area. The specific habitats focused on within the sections below are the habitats that would be created by the Corps on-site or off-site, including GGS upland habitat and habitat for VELB. In addition, mitigation sites would be created which present a combination of riparian, oak woodland, and SRA habitats, which are highly related and provide value to a number of listed species, including VELB, Western yellow-billed cuckoo, and fish species.

2.1 GGS Uplands Mitigation

2.1.1 Objectives and Implementation Strategy

The primary objective of upland habitat mitigation is to restore upland refugia habitat for the giant garter snake (*Thamnophis gigas*) (GGS) in a manner consistent with adjacent equitable habitat. Upland refugia habitat is generally considered native grasslands with space appropriate for basking, cover, and retreat sites for GGS. Upland refugia is also considered higher elevation areas for cover and refuge from flood waters. Upland refugia restoration would take place on grasslands adjacent to GGS wetland habitat as well as levee slopes for higher elevation refuge. These conservation and restoration measures are taken from the Guidelines for Restoration and/or Replacement of Giant Garter Snake Habitat (USFWS, 1997).

Restoring GGS habitat includes minimizing the potential impacts of project activities to the existing habitat. Use of silt fencing and protective mats to prevent runoff and reduce the possibility of individual GGS from entering the project area is recommended. Designation of environmentally sensitive areas and providing worker awareness training is also recommended. Construction activities should be 200 feet from GGS aquatic habitat, and should occur between May 1 and October 1. Project areas should be surveyed for GGS 24 hours prior to ground disturbing activities, and surveys should be repeated if a lapse in construction activity of two weeks or greater has occurred. If aquatic habitat must be removed as part of the construction activities, any dewatering would occur after April 15 and dewatered habitat would be left dry for at least 15 consecutive days.

Upon the completion of construction, the area would be regraded to the preexisting contour. Upland refugia would be hydroseeded with native grasses. USFWS recommends a mix of native grass seeds such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Additional native plant seeds consistent with adjacent habitat may be used at the discretion of USFWS. Permanent irrigation would not need to be established for this habitat type, however the site would require periodic watering in drought conditions (USFWS 1997).

2.1.2 Success Criteria

Monitoring of GGS upland habitat would focus on: (1) the percentage cover of native species, and (2) the percentage of overall vegetative cover. The restored habitat would be considered successful if 75 percent of the vegetation on site consists of native species. Additionally, the overall vegetative cover on site must be 95 percent.

2.1.3 Mitigation Monitoring Strategy

Restored habitat should be monitored for one year following implementation. Surveys would involve a general overview of the condition of the site, an estimate of ground cover, and a passive (observation only) GGS survey to determine potential habitat use. A ground cover survey would occur to determine the ground cover percent of native and non-native species. Ground cover surveys, if determined by the Corps to be needed to evaluate the success of the mitigation area, would involve the use of a one square meter quadrat placed haphazardly in the restored areas. Once placed, all herbaceous vegetation within the quadrat would be recorded to species level. The percent of cover by native and non-native species would be determined in addition to the percent of total cover.

Monitoring reports documenting the restoration effort would be submitted to USFWS upon completion of the restoration implementation and one year from restoration implementation. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, plantings (if specified), and justification of any substitutions to USFWS recommended guidelines. Monitoring reports would also include recommendations for additional remedial actions, if necessary.

2.1.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of GGS upland habitat.

  Trigger: 95% cover is not achieved within one year.

- Desired Outcome: Decrease percent of non-native invasive species that outcompete natives.

  Trigger: Non-native percent cover of more than 25% within one year.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for GGS upland habitat in order to adaptively manage the site for success.

- If the performance criteria are not met within one year, additional plantings and monitoring would be implemented in order to ensure that the site is successful.
- If non-native species are outcompeting the native species, measures would be implemented to manage presence of invasive species, including mowing and selective removal of non-native species at optimal times for native growth.
- If non-native species are outcompeting the native species and targets for overall cover are not being met, then revegetation of native species would occur.
- Supplemental watering if targets for overall cover are not being met.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

2.2 Riparian Habitat

2.2.1 Objectives and Implementation Strategy

The primary objective of riparian habitat mitigation is to compensate for impacted habitat types and community types, and reduce erosion rates within the alluvial floodplain. Native plant communities and streambank vegetation would be represented in species density appropriate to the surrounding area. As native vegetation matures, it helps to stabilize stream banks and shorelines; provides food, shelter, shade, and access to adjacent habitats; nursery habitat; pathways for movement by resident and nonresident aquatic, semi-aquatic, and terrestrial organisms; and improves and protects water quality by reducing the amount of sediment and other pollutants such as pesticides, organic materials, and nutrients in surface runoff. The long term goal of riparian mitigation is to provide habitat similar to the habitat that was impacted by project construction. These improvements would enhance nesting opportunities for native bird species, and provides opportunities to satisfy VELB compensation.

Riparian vegetation would include large woody species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), white alder (*Alnus rhombifolia*), and box elder (*Acer negundo var. californicum*); shrub-scrub species such as elderberry (*Sambucus spp.*), redbud (*Cercis Canadensis*), and coyote brush (*Baccharis pilularis*); and understory species such as California rose (*Rosa californica*), California blackberry (*Rubus ursinus*), and wild grape (*Vitus californica*); and native grasses such as annual fescue (*Vulpia* spp.), California brome (*Bromus carinatus*), blue wildrye (*Elymus glaucus*), and needle grass (*Nassella* spp.). Native trees and shrubs provide a buffer to adjacent urban and industrial land uses, and provide habitat structure for wildlife. Leaf litter and large organic debris would create a variety of microhabitats, increasing species diversity and potentially creating a prey base for larger predators.

The riparian mitigation site would likely require fencing to protect establishing habitats from recreation, wildlife, and other potential damages. The site would have irrigation during the establishment period, and would be watered as needed until the vegetation is established and self-sustaining. Mowing would occur periodically to ensure that weed species do not shade out new plantings.

2.2.2 Success Criteria

Monitoring of riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; (3) percentage of canopy cover over water; and (4) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an qualitative inventory of wildlife species would be recorded during annual monitoring. Table 30 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

Table 30. Riparian Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent cover of native plant species	75%
Structural diversity	At least five native species contributing to 75% canopy and 50% shrub cover
Percent of canopy cover over water per LF	75%
Percent cover of non-native species	Less than 15%

2.2.3 Mitigation Monitoring Strategy

The following monitoring procedures will provide the information necessary to evaluate the success of riparian habitat mitigation. Vegetation sampling will occur annually for the duration of the monitoring period. Sampling will occur during spring months, at the peak of growing season, and will consist of permanent field monitoring plots along one or more transects either perpendicular to the river or parallel to the floodplain slope. Plots will be located randomly within each site, and the distance between plots and along transects will be site specific. Woody species with overhead canopy cover that falls along the vegetation monitoring transect, including those that were planted, have recruited naturally to the site, or were existing at the site prior to planting efforts would be recorded. Monitoring will measure percent cover of native and non-native plant species, structural diversity, and percent cover over water. Photograph stations are also important for documenting vegetation conditions. All plots and photograph stations will be documented via Global Positioning System (GPS) coordinates to maintain consistency throughout the monitoring period.

Additionally, field personnel would visually estimate the height (+/- 2 feet) of each tree and shrub that provides overhead canopy cover. Exact heights are not necessary, since there is no tree height criterion included in this protocol. Rather, approximate tree heights would be visually assessed to monitor tree growth over time. Data collected would include species name, location (feet) along the vegetation monitoring transect (upper extent of canopy and lower extent of canopy), whether the tree or shrub is planted (P), recruited (R), or existing (E), height (feet), and vigor as determined using the metric outlined in Table 31, below.

Table 31. Estimation of General Health and Vigor for Plant Species.

Visual Estimate of Foliage	Vigor Category	Value
81 percent (or greater) of foliage appears to be healthy	Excellent	4
51 to 80 percent of foliage appears to be healthy	Good	3
25 to 50 percent of foliage appears to be healthy	Fair	2
Less than 25 percent of foliage appears to be healthy	Poor	1
Dead	Dead	0

General observations, such as fitness and health of plantings, native plant species recruitment, and signs of drought stress would be noted during the surveys. Additionally, potential soil erosion, flood damage, vandalism and intrusion, trampling, and pest problems would be qualitatively identified. A visual check of irrigation infrastructure and fencing would also be conducted. A general inventory of all wildlife species observed and detected using the mitigation site would be documented. Nesting sites and other signs of wildlife use of the newly created habitat would be recorded.

Monitoring reports documenting the restoration effort would be prepared following the first monitoring period and would continue annually until the site has met the success criteria. Monitoring reports would include photos, the timing of the completion of the restoration, what materials were used in the restoration, and plantings (if specified). Monitoring reports would also include recommendations for additional adaptive management measures, if necessary. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

2.2.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Increase percent vegetative cover over water per linear foot to support native fish.

  Trigger: If percent cover over water is not 30% within 3 years, and 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for riparian habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover, vegetative cover over water, and/or structural diversity are being met. Monitoring results should be used to assess the underlying cause of inadequate cover, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting varieties of species that are exhibiting the greatest growth and survival, or planting at elevations that are exhibiting the greatest growth and survival.

- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or structural diversity are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

2.3 Elderberry Shrubs

2.3.1 Objectives and Implementation Strategy

The primary objective of elderberry shrub mitigation is to compensate for the adverse effects of the project on habitat important to the Federally listed valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). Where possible, conservation areas would connect with adjacent habitat in order to prevent isolation of beetle populations. Removal, transplanting, and establishment of elderberry shrubs would be coordinated with USFWS and would follow the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999).

Elderberry shrubs with one or more stems measuring one inch or greater in diameter at ground level must be transplanted if they cannot be avoided by the proposed project. Elderberry shrubs should be transplanted when they are dormant, typically from November to the first two weeks in February. Transplanting during the non-growing season would reduce shock to the plant and increase transplantation success. Most transplants require watering through the first summer.

Elderberry stems measuring greater than one inch in diameter are habitat for the VELB, therefore trimming or removing stems would require coordination and mitigation. Each elderberry stem that is adversely affected must be replaced in the conservation area with elderberry seedlings or cuttings as specified by USFWS. Seedlings and cuttings should be obtained from local sources. If the project is in the vicinity of the conservation area, cuttings may be obtained from elderberry shrubs to be transplanted

Mitigation site planting areas must be at least 1,800 square feet for each elderberry transplant. As many as five additional elderberry plantings (cuttings or seedlings) and up to five associated native species plantings may also be planted within the 1,800 square foot area with the transplant. Studies have found that the VELB is more abundant in dense native plant communities with a mature overstory and a mixed understory. Therefore, a mix of native riparian species such as Fremont cottonwood (*Populus fremontii*), California sycamore (*Platanus racemosa*), valley oak (*Quercus lobata*), box elder (*Acer negundo*), white alder (*Alnus rhombifolia*), and California button willow (*Cephalanthus occidentalis californica*) would be planted along with the elderberry shrubs. Stock of saplings, cuttings, and seedlings would be obtained from local sources. Planting or seeding the area with native herbaceous species is also encouraged. Weeds and other non-native plants would be removed by mechanical means at least once a year or at the discretion of USFWS.

No pesticides, herbicides, fertilizers, or other chemical agents would be used in or within 100 feet of the conservation area. Fencing would be placed around the conservation area during the establishment period of the elderberry shrubs. Signs would be posted on the fence stating the status of the VELB and the purpose of the habitat. The conservation area would be protected in perpetuity as habitat for the VELB. Conservation areas may be transferred to resource agencies or appropriate private organizations for long term management. Biologists and law enforcement personnel from the California Department of Fish and Wildlife and USFWS must be given complete access to the project site to monitor transplanting activities. Personnel from these agencies must also be given complete access to the conservation area to monitor the beetle and its habitat in perpetuity.

2.3.2 Success Criteria

After the first year, it is anticipated that the sites would be evaluated to determine the level of project success and apply adaptive management, if necessary. If the habitat meets the below performance standards for three consecutive years, depending on physical site characteristics, conditions should be consistent enough to estimate community composition and general success of planting efforts. Three consecutive years of success should indicate that the project sites are self-sustaining and should not require supplemental irrigation or intensive weed control. Following this initial establishment period, any subsequent monitoring activities would be the responsibility of the local maintaining agency, and would focus primarily on general and biological inspections for the purposes of fire management and habitat evaluation.

Monitoring of elderberry habitats would focus on a minimum survival rate of at least 60 percent of the elderberry shrubs. Within one year of discovery that survival has dropped below 60 percent, additional plantings would be installed to bring survival above this level. Monitoring of associated riparian habitat would focus on: (1) the percent cover of native plant species; (2) presence of at least five native species contributing to structural diversity; and (3) decrease percent cover of non-native invasive species that out-compete natives. Additionally, an inventory of wildlife species would be recorded during annual monitoring. Table 32 establishes the percentages required to meet these performance standards. If the habitat is meeting these performance standards, conditions should be consistent enough to estimate community composition and general success of planting efforts.

Table 32. Elderberry and Associated Riparian Habitat Performance Standards.

Performance Standard	Quantitative Measure
Percent survivability of elderberry shrubs	60%
Percent cover of native riparian species	75%
Structural diversity	At least 5 native species contributing to 75% canopy and 50% shrub cover
Percent cover of non-native species	Less than 15%

2.3.3 Mitigation and Monitoring Strategy

Monitoring would be conducted annually per the USFWS Conservation Guidelines for the valley elderberry longhorn beetle (USFWS, 1999). Two surveys would be conducted by qualified biologists between February 14 and June 30 of each year until the mitigation has met the success criteria. Surveys would include:

1. An evaluation of the elderberry plants and associated native plants on the site, including the number of plants, their size and condition.
2. Presence of the adult beetles, including the number of beetles observed, their condition, behavior, and their precise locations.
3. Presence of beetle exit holes in elderberry stems, noting their locations and estimated ages.
4. An evaluation of the adequacy of the fencing, signs, and weed control efforts in the avoidance and conservation areas.
5. A general assessment of the habitat, including any real or potential threats to the beetle and its host plants, such as erosion, fire, excessive grazing, off-road vehicle use, vandalism, excessive weed growth, etc.

A written report presenting and analyzing the data from the project monitoring would be prepared following the surveys, and would be submitted by December 31 of the same year to USFWS. The report would address the status and progress of the transplanted and planted elderberry shrubs, associated native plants and trees, and any failings of the conservation plan and the steps taken to correct them. Any observations of beetles or fresh exit holes must be noted. Copies of original field notes, raw data, and photographs of the conservation area would be included with the report. A vicinity map of the site and maps showing where the individual adult beetles and exit holes were observed would also be included. The survival rate, condition, and size of the elderberry and associated native plants would be analyzed in the report. Real and likely future threats would be addressed along with suggested remedies and preventative measures (such as limiting public access, more frequent removal of invasive non-native vegetation, etc.).

2.3.4 Adaptive Management Strategy

If the habitat is not meeting the success criteria established above, then adaptive management would be implemented in order to ensure that the habitat establishment is successful. The following subsections identify triggers that would indicate the need to implement adaptive management measures and the measures that would be implemented accordingly.

Adaptive Management Triggers

- Desired Outcome: Increase percent survivability of elderberry shrubs.

  Triggers: If 60% survivability is not achieved during the monitoring period.

- Desired Outcome: Increase percent cover of native riparian habitat.

  Triggers: If 50% cover of native riparian habitat is not achieved within 3 years, or 75% cover of native riparian habitat is not achieved within 5 years.

- Desired Outcome: Maintain appropriate structural diversity of native riparian habitats.

  Trigger: Suitable structural diversity is not achieved, if canopy cover and/or shrub cover does not achieve 50% within 5 years.

- Desired Outcome: Decrease percent cover of non-native invasive species that outcompete natives including elderberry shrubs.

  Trigger: If non-native percent cover is greater than 15% during the monitoring period.

Adaptive Management Measures

If the triggers established above occur, the following measures would be implemented for VELB habitat in order to adaptively manage the site for success.

- Replanting may be needed if triggers for vegetative cover and/or survivability are being met. Monitoring results should be used to assess the underlying cause of inadequate cover or survival, which may require that additional adaptive management actions be implemented to support successful replanting. Adaptive management actions could include targeted revegetation, such as replanting at elevations that are exhibiting the greatest growth and survival.
- Nonnative species management may be needed if monitoring results show that the triggers for nonnative species present are met, or if nonnative species are impacting the survival of native species including elderberry shrubs. Adaptive management measures may include adjustments to nonnative control methods, such as plant removal, grading of site to remove nonnative roots, or mowing and selective removal of non-native species at optimal times for native growth.
- Irrigation and/or supplemental water may be needed if vegetation is not meeting success criteria, or if species are exhibiting signs of water stress. Assessment of monitoring results may show that drought conditions are causing poor establishment or die off of planted vegetation. Adaptive management actions would include supplemental water to support achievement of percent cover criteria and structural diversity.
- Plant protection may be needed if triggers for vegetative cover and/or survivability are being met. If monitoring results show that plantings are failing due to predation or trampling from human use, then adaptive management actions would include plant cages or protective fencing that could be installed to protect plantings.

These measures are described further in the Adaptive Management Plan (Section 3.0) below.

3.0 ADAPTIVE MANAGEMENT COSTS

This section outlines the feasibility level adaptive management costs for the LSJR study Recommended Plan. The adaptive management plan for this project reflects a level of detail consistent with the project Feasibility Study. The primary intent is to develop adaptive management costs appropriate for and specific to the project's adaptive management measures and monitoring strategies, as described in Section 2.0 of this document. The specified management actions allow estimation of the adaptive management program costs for the project.

3.1 Monitoring and Adaptive Management Costs

The cost for implementation of this plan are provided at October 2015 price levels and prior to contingency. The cost for implementing the monitoring plan proposed above is approximately $250,000 and is shown on Table 33 below. These costs are proposed to be cost-shared rather than an O&M cost, because the mitigation being created is associated with requirements of the USFWS BO that was issued to the Corps. The conservation measures identified in the BO include monitoring requirements that the Corps proposes to implement at the cost displayed in Table 33 below.

Table 33. Monitoring Costs for the LSJR Study Recommended Plan.

Monitoring	Assumed Tasks for Monitoring	Frequency	Cost Assumptions	Total Cost for 5 Years
Vegetation Monitoring	Assume monitoring of mitigation site, including transects for percent cover of natives and non-natives, structural diversity, and canopy cover over water using transect/plot monitoring. Assume vegetation mapping, inventories of general wildlife, and observations of damage to habitat would be recorded. Assume monitoring of all parameters would be done concurrently during each monitoring event.	Annually for 5 Years	Monitoring: Cost estimate based on standard establishment contract, including monitoring cost and annual report from contractor. Assume $50,000 per year for 4 biologists to survey mitigation site	$250,000
			TOTAL MONITORING	**$250,000**

The cost for the adaptive management plan is approximately $600,000 and is shown on Table 34 below.

Table 34. Adaptive Management Costs for the LSJR Study Recommended Plan.

Adaptive Management Measures	Assumed Tasks for Adaptive Management	Cost Assumptions	Total Cost for 5 Years
Irrigation/Supplemental Water	Apply supplemental irrigation to water stressed plants	Assuming $900 per acre per year for 5 years	$63,000
Re-planting	Assume that assume 25% of vegetation may require replanting over 5 years.	Cost of vegetation was estimated at $5,000 per planted acre	$260,700
Plant Protection & Fencing	Assume 400 plant cages and 11,500 feet of fencing may be needed to surround 14 acres.	Assume $10/plant cage; $3/linear foot for fencing; plus $50,000 installation. Costs referenced from existing restoration contracts.	$88,500
Annual Report	Produce annual report	Assume $37,500 per report, annually for 5 years	$187,500
		TOTAL ADAPTIVE MANAGEMENT	**$599,700**
		TOTAL MONITORING AND ADAPTIVE MANAGEMENT	**$849,700**

The combined monitoring and adaptive management costs at October 2015 price levels, as included in the certified total project cost summary under the 06 “fish and wildlife facilities” account, total $849,000 for the Recommended Plan.

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ENVIRONMENTAL ADDENDUM K

AIR QUALITY

LOWER SAN JOAQUIN FEASIBILITY STUDY

Appendix Air. Summary of RECM Results for Each Alternative

Alternative 7A -Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.3	8.8	17.7	0.3	6.7	1.9	3,661	3,487
2020	1.2	8.8	15.3	0.3	6.7	1.8	3,614	3,442
2021	1.1	8.9	12.0	0.3	6.6	1.8	3,606	3,435
2022	1.7	16.5	14.6	0.3	5.7	1.7	5,132	4,887
2023	1.4	14.1	11.6	0.3	5.4	1.5	3,535	3,367
2024	0.7	8.2	5.3	0.2	4.7	1.1	1,759	1,675
2025	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2026	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2027	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2028	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2029	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	71.19260
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 665,650.78

Alternative 7a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.1
2020	7.7
2021	6.7
2022	8.7
2023	7.5
2024	3.8
2025	3.9
2026	3.9
2027	3.9
2028	3.9
2029	3.9
SJVAPCD Threshold	10

Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
43.4%	$ 71,781.36	
34.5%	$ 49,324.53	
16.9%	$ 18,982.96	
31.6%	$ 43,285.75	
13.6%	$ 14,776.19	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 198,150.78	

	Tier 3			
	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 7B Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2026	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2027	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2028	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2029	0.6	5.9	5.0	0.3	5.3	1.3	1,812	1,726
2030	0.4	4.3	3.3	0.3	5.8	1.3	1,021	972
2031	0.4	4.0	3.0	0.2	4.7	1.1	857	816
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	94.3
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 882,163.70

Alternative 7b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.2
2026	8.2
2027	8.2
2028	8.2
2029	4.1
2030	3.3
2031	3.0
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No

Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,031.78	
40.1%	$ 62,574.95	
25.6%	$ 32,233.38	
38.8%	$ 59,172.61	
32.8%	$ 45,681.53	
28.1%	$ 36,469.46	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

	$ 321,163.70

Alternative 8A Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,414	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	17.8	16.0	0.3	6.1	1.8	5,932	5,649
2023	1.8	17.7	14.6	0.3	6.0	1.8	5,924	5,642
2024	1.3	14.1	10.8	0.3	5.4	1.5	3,536	3,367
2025	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2026	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2027	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2028	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
2029	0.8	9.2	6.1	0.2	4.0	1.0	2,405	2,290
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	90.7
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 848,062.44

Alternative 8a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.6
2023	9.5
2024	7.6
2025	5.0
2026	5.0
2027	5.0
2028	5.0
2029	5.0
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10

Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,027.94	
40.1%	$ 62,571.11	
25.6%	$ 32,229.54	
37.7%	$ 56,532.33	
31.7%	$ 43,342.13	
7.3%	$ 7,359.39	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 287,062.44	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 8B Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2026	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2027	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2028	1.3	14.0	10.2	0.4	7.2	1.8	5,134	4,889
2029	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
2030	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
2031	0.7	6.5	5.5	0.3	6.3	1.5	2,007	1,911
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2024	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2024	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA

Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	135.0
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$1,262,584.76

Alternative 8b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.4
2026	8.4
2027	8.4
2028	8.4
2029	4.5
2030	4.5
2031	4.5
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
47.6%	$ 85,031.78	
40.1%	$ 62,574.95	
25.6%	$ 32,233.38	
38.8%	$ 59,172.61	
32.8%	$ 45,681.53	
28.1%	$ 36,469.46	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
1.7%	$ 1,605.27	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
	$ 327,584.76	

Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%
2030	61%	17%	7%	-1%
2031	61%	17%	7%	-1%

Alternative 9A Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.3	8.8	17.7	0.3	6.7	1.9	3,661	3,487
2020	1.2	8.8	15.3	0.3	6.7	1.8	3,614	3,442
2021	1.1	8.9	12.0	0.3	6.6	1.8	3,606	3,435
2022	1.7	16.5	14.6	0.3	5.7	1.7	5,132	4,887
2023	1.4	14.1	11.6	0.3	5.4	1.5	3,535	3,367
2024	0.7	8.2	5.3	0.2	4.7	1.1	1,759	1,675
2025	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2026	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2027	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2028	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
2029	0.6	7.9	4.7	0.2	3.5	0.9	1,605	1,528
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA
Parameter	

Total Unmitigated Nox Exceeding 10 tons per year	71.2
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 665,650.78

Alternative 9a Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.1
2020	7.7
2021	6.7
2022	8.7
2023	7.5
2024	3.8
2025	3.9
2026	3.9
2027	3.9
2028	3.9
2029	3.9
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10
Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox

Tier 3

	ROG	Nox	PM10	PM2.5

43.4%	$ 71,781.36
34.5%	$ 49,324.53
16.9%	$ 18,982.96
31.6%	$ 43,285.75
13.6%	$ 14,776.19
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
0.0%	$ -
	$ 198,150.78

2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%

Alternative 9B
Summary

	ROG (tons/yr)	CO (tons/yr)	NOx (tons/yr)	SO2 (tons/yr)	PM10 (tons/yr)	PM2.5 (tons/yr)	CO2e (metric tons/yr)	CO2 (metric tons/yr)
2019	1.5	10.1	19.1	0.4	7.2	2.0	4,461	4,249
2020	1.4	10.1	16.7	0.4	7.1	2.0	4,415	4,204
2021	1.3	10.2	13.4	0.4	7.1	1.9	4,407	4,197
2022	1.9	18.0	16.3	0.4	7.5	2.1	5,986	5,701
2023	1.8	17.9	14.9	0.4	7.4	2.1	5,978	5,694
2024	1.7	17.9	13.9	0.4	7.4	2.0	5,981	5,696
2025	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2026	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2027	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2028	1.3	14.2	10.0	0.3	6.7	1.7	3,560	3,391
2029	0.6	5.9	5.0	0.3	5.3	1.3	1,812	1,726
2030	0.4	4.3	3.3	0.3	5.8	1.3	1,021	972
2031	0.4	4.0	3.0	0.2	4.7	1.1	857	816
SJVAPCD Threshold	10	100	10	27	15	15	None	None
Exceed SJVAPCD Threshold?	No	No	Yes, 2019-2029	No	No	No	N/A	N/A
Conformity Threshold	10	100	10	100	100	100	25,000	25,000
Exceed Conformity Threshold?	No	No	Yes, 2019-2029	No	No	No	No	No

SO2 emissions not estimated by RCEM. However, SO2 typically less than 5% of PM10 exhaust. Consequently, SO2 conservatively assumed to equal 5% of PM10.

	VERA

Parameter	
Total Unmitigated Nox Exceeding 10 tons per year	94.3
Estimated Mitigation Fee ($9,350/ton Nox)	$ 9,350.00
Total Cost	$ 882,163.70

Alternative 9b Summary (Mitigated)

Year	NOx (tons/yr)
2019	8.8
2020	8.4
2021	7.5
2022	9.7
2023	9.7
2024	9.8
2025	8.2
2026	8.2
2027	8.2
2028	8.2
2029	4.1
2030	2.8
2031	2.5
SJVAPCD Threshold	10
Exceed SJVAPCD Threshold?	No
Conformity Threshold	10

Exceed Conformity Threshold?	No

% Nox Reduction Needed	9350	$/ton Nox
82.6%	$ 147,437.52	
80.1%	$ 124,980.70	
75.3%	$ 94,639.13	
79.6%	$ 121,578.36	
77.7%	$ 108,087.28	
76.1%	$ 98,875.21	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
0.0%	$ -	
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Tier 3

	ROG	Nox	PM10	PM2.5
2019	75%	54%	55%	51%
2020	74%	50%	50%	46%
2021	71%	44%	43%	38%
2022	70%	40%	38%	32%
2023	68%	35%	31%	25%
2024	66%	29%	23%	16%
2025	61%	17%	7%	-2%
2026	61%	17%	6%	-2%
2027	61%	17%	7%	-2%
2028	61%	17%	7%	-2%
2029	61%	17%	7%	-1%
2030	61%	17%	7%	-1%
2031	61%	17%	7%	-1%

Appendix C
Fish and Wildlife Coordination Act Report and Supplement and Biological Opinions

ENVIRONMENTAL ADDENDUM B

FISH AND WILDLIFE COORDINATION ACT REPORT

LOWER SAN JOAQUIN RIVER FEASIBILITY STUDY

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer to:
08ESMF00-
2014-CPA-0012

JUL 25 2016

Ms. Alicia Kirchner
Chief, Planning Division
Sacramento District
U. S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Subject: Transmittal of the final Fish and Wildlife Coordination Act report for the Lower San Joaquin River Feasibility Study

Dear Ms. Kirchner:

Please find enclosed the U.S. Fish and Wildlife Service's final Fish and Wildlife Coordination Act report for the Lower San Joaquin River Feasibility Study.

If you have any questions, please contact Steven Schoenberg of my staff at (916) 414-6564.

Sincerely,

Kaylee Allen

Kaylee Allen
Field Supervisor

Enclosure

cc:
Tanis Toland, COE, Sacramento, CA
Jeffrey Stewart, NMFS, Sacramento, CA
Kursten Sheridan, CDFW, Rancho Cordova, CA
Jim Starr, CDFW, Stockton, CA
Ruth Darling, DWR, Sacramento, CA
Roger Churchwell, SJAFCA, Stockton, CA

UNITED STATES DEPARTMENT OF THE INTERIOR

FISH AND WILDLIFE SERVICE

FINAL FISH AND WILDLIFE COORDINATION ACT REPORT FOR THE

LOWER SAN JOAQUIN RIVER FEASIBILITY STUDY

PREPARED BY:

Steven Schoenberg, Senior Fish and Wildlife Biologist
U.S. Fish and Wildlife Service
Habitat Conservation Division
San Francisco Bay-Delta Fish and Wildlife Office
Sacramento, California

PREPARED FOR:

U.S. Army Corps of Engineers
Sacramento District
Sacramento, California

July 2016

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FINAL FISH AND WILDLIFE COORDINATION ACT REPORT FOR THE LOWER SAN JOAQUIN RIVER FEASIBILITY STUDY

INTRODUCTION

This document constitutes the Fish and Wildlife Service's (Service) final detailed report on the U.S. Army Corps of Engineers (Corps) Lower San Joaquin River Feasibility Study. The Lower San Joaquin River Feasibility Study covers a region that includes the communities of Stockton, Lathrop, and Manteca, where there is a significant risk associated with flooding. The feasibility study has planning objectives to reduce flood risk, develop plans to address and communicate residual flood risks, and develop ecosystem restoration or enhancement features coincident with flood risk management.

Prior Service involvement began with attendance at a kick-off meeting in 2009. A 2-day site visit to representative locations occurred on May 29-30, 2013. On August 15, 2013, we provided a staff-level Planning Memorandum outlining the potential effects of the project in the north, central, and south areas of the project, based on the 2013 site visit and prior involvement on a separate, Section 408 proposal known as the Reclamation District (RD) 17 Phase III Seepage Area Project; this project overlaps one of the elements considered in the feasibility study, but differs in the extent and types of work (Service 2013). A formal coordination document was not prepared for the 408 project due to lack of Corps or other funding. However, we did attend a site visit in March 2011 to RD 17, and submitted a comment letter on the Draft Environmental Impact Statement/Report (DEIS/R) for the RD 17 Phase III Seepage Area Project, which we appended to the 2013 Planning Memorandum for this project (Service 2011).

The Service transmitted a draft detailed report for the feasibility study in June 2014 (Service 2014). That report was based on incomplete information about the affected habitat and mitigation. We recommended that the Corps develop additional information on affected resource quantities, including by ground surveys, develop a setback alternative for the RD 17 element, consult with the Service and other agencies on listed species, and develop enhancement and restoration opportunities to the maximum extent possible. In February 2015, the Corps issued its Draft Interim Integrated Feasibility Report/Environmental Impact Statement for the project that included responses to our recommendations (Corps 2015a). In those responses, the Corps stated it had used assumptions to estimate impacts and would conduct field surveys later to verify these estimates, and develop other specifics such as staging and borrow areas during the Preliminary Engineering and Design (PED) phase of planning. The Corps believed it had considered restoration opportunities already, but none were included in the proposed action. The Corps also stated that more extensive setback levees were screened out due to costs.

The Corps initiated formal consultation with the Service in February 2015 under Section 7 of the Endangered Species Act (ESA). That formal consultation process included Corps field surveys in summer 2015 to assess elderberry shrubs and identify giant garter snake habitat, an additional site visit with the Service in January 2016, developing revised information on closure gate operations, and developing conservation measures for all listed species including, where appropriate, site-specific measures, and near-site mitigation or conservation bank credit purchase appropriate to offset effects. This information is summarized in the Corps' revised Biological Assessment (Corps 2015c) and the Service's Biological Opinion (Service 2016).

Coordination between the Service and other resource agencies has remained limited throughout project planning. Initially, we had made brief informal contact with the National Marine Fisheries Service (NMFS) and the Environmental Protection Agency staff on their views. These agencies had previously commented on the RD 17 Phase III section 408 project in 2011. The California Department of Fish and Wildlife (CDFW) was previously contacted regarding their general guidance on mitigation for urban trees, but not specifically on the feasibility study. Since our draft detailed report, the Corps held one meeting with the resource agencies on July 22, 2014 which included general discussions of the consultation process and mitigation possibilities. In June 2016, the Service informally contacted representatives of NMFS (Jeff Stewart, Sacramento, West Coast Region) and one of two CDFW regions with regulatory authority for this project (Kursten Sheridan, Rancho Cordova, Region II) to discuss concerns and recommendations for this detailed report. This limited coordination between the Service and other resource agencies has been a consequence of funding and schedule constraints under the Corps' 3x3x3 planning guidance rule (Corps 2015b), and the Corps' desire to first complete consultation requirements with the resource agencies, which limited the time remaining in the schedule for interagency coordination.

Information considered in this report includes observations during site visits, draft materials transmitted informally for our use by the Corps on this project (e.g., image files, tables, powerpoint presentations, revised draft narratives for the feasibility study), the DEIS/R for the RD 17 Phase III Seepage Project (Corps and RD 17 2011), our files for the Corps formal consultation on this project including revised vegetation loss estimates by location (see Service 2016, Appendix B), information on potential temporary and permanent impacts on upland and aquatic giant garter snake habitat (March 10, 2016 email), revised description and projected operations of the Fourteenmile Slough closure structure (June 2 and 3, 2016 emails), a partial "working draft" mitigation plan (June 17, 2016 email), and other materials in our files.

ALTERNATIVES

The Corps considered a variety of structural measures and work elements for a study area that included central and north Stockton, and RD 17 to the south. Below, we describe these measures, how they would be applied to each potential work element, and then the combinations of work elements which form the alternatives. A separate section of this report follows which provides more detail on the preferred alternative, which is the Corps' proposed project.

Structural Measures:

Cutoff Walls: This measure is used to address seepage issues. Sites are cleared, grubbed, and the levee is degraded at least one half its height. A 3-foot minimum width trench is excavated to impermeable soil (variable depth) and filled with bentonite slurry during this excavation. After the slurry has cured, an impervious cap is installed. Finally, the levee is reconstructed. In some areas which cannot be easily accessed such as around utilities and at bridges along levees, a jet grouting method will be used to install the cutoff wall.

Slope Reshaping: This measure is used to restore levees to Corps design criteria for sideslope and crown width. It is done by clearing and grubbing the waterside crest, crown, and landside slope, removing 0.5-1 feet (ft) and sometimes up to 2 ft of material. Suitable material is then placed on the landside and the slope shaped to meet Corps design criteria. Material needed to correct levee geometry will be placed only on the land side, but reshaping may occur on both land and water sides. If this reshaping requires removal of rock revetment, the rock will be replaced. Relocation of land side toe drains and ditches will be done where required.

Levee Raise: For this study, levee raising would be done where needed to achieve 200-year protection and/or for sea level rise protection. The work is accomplished in the same manner as with slope reshaping, except that after suitable material is placed, the levee is rebuilt to a greater specified height. These locations will also first require either a cutoff wall or seismic fix measure. Borrow material will be added to the land side after cutoff walls and levee reshaping improvements are completed.

Seepage Berm: This measure is an alternative treatment to cutoff walls to address seepage issues. It is a berm built on the landside of the levee, usually ranging from 150-200 ft wide, and is 3-5 ft high. Construction involves clearing and grubbing, and placement of successive layers of sand, gravel and soil (with filter fabric between the gravel and soil). Seepage berms are not proposed in the preferred alternative, but are proposed in intermittent sections of RD 17 in other alternatives.

New Levee: This measure is used to reduce the flood risk of outflanking, or as an alternative to repairing existing levees by setting the levee back. Construction involves clearing and grubbing, then excavating an inspection trench. Material is placed, watered, and compacted, then shaped to design specifications. A cutoff wall is also installed, if determined by inspection to be needed. Slopes are then armored with stone riprap as needed, and the remainder reseeded with grasses to prevent erosion. This measure applies to portions of Duck Creek, Smith Canal, and RD 17 work.

Erosion Protection: This measure applies to areas which could be subject to high flows, tides, or wave action, during large events, which includes the Delta Front and RD 17 work elements, depending on alternative. It entails placing stone riprap on the entire slope of the levee from toe to crown.

Seismic Remediation: Used to reduce deformations during earthquakes, this measure involves installing a grid of soil-cement mix columns. This measure will be applied to Fivemile, Fourteenmile, and a portion of Tenmile Sloughs. It requires clearing, grubbing, and degrading the levee to one-half its height. The columns are created using a deep soil mixing auger, and then the levee is reconstructed with suitable material.

Setback: This measure involves constructing the levee away from the edge of the waterway, providing an area outside of the levee profile that would be relatively free of maintenance and can support vegetation. It would be used in sections of RD 17 and Fourteenmile Slough.

Closure Structure: This measure is proposed at the mouth of Smith Canal and across Fourteenmile Slough at the location where it transects the delta front levees. The purpose is to prevent flooding from the San Joaquin River and Delta; for Fourteenmile Slough, it also will limit the level and duration of water saturation due to higher tides on private levees to the east to reduce the risk of their failure. Each structure will consist of a fixed sheet pile wall with a 50-foot-long opening gate structure to allow tidal flows and boats to pass when open. The structure will tie into high ground, either the new berm for the Smith Canal structure or the levee for the Fourteenmile Slough structure. A small building will be needed for each structure. The structures will be routinely closed during any water stage equal to or greater than 8 ft North American Vertical Datum of 1988 (NAVD88) caused by high tides or high tide in combination with rain on snow flood events, as well as during emergency (e.g., failure along Smith Canal and Fourteenmile Slough levees to the east). The frequency and duration of gate closure operation is expected to increase during wetter water years, and will become much more common over the project life due to sea level rise. After project completion, around 2025, the closure structures would be operated only during the wettest year types such as was the case in 1983 and 1997. By 2070, sea level rise is expected to require gate closure for a full tidal cycle every day in wet years for months at a time. In other water year types, there will also be frequent, shorter-term closures for 2-4 hours per day for several days to weeks in all months.

Control Structure and Bypass Channel: This measure would allow use of old Mormon Slough, or "Mormon Channel," as a flood bypass which runs from the Stockton Diverting Canal to the San Joaquin River. By taking off the peak of flood flows, this measure is an alternative to improvements along the Stockton Diverting Canal and portions of the lower Calaveras River. To do this, a box culvert with a 12-foot-high radial gate would be installed where Mormon Channel meets the Stockton Diverting Canal. There are a number of low-water crossings which need to be removed or replaced with bridges, some channel widening, and several culvert modifications. It is designed to carry 1,200 cubic ft per second at most, and would be operated not more than every 2 years or so. The amount of flow and duration varies with the size of the event but it would be intermittent, flowing a few days, every few years. There may be other necessary work in Mormon Channel, such as remediation of any contaminants present in the slough, and restoration actions involving earthwork or plantings, but these have not yet been described.

Work Elements:

The Corps developed work elements described by location, with individual or combinations of structural measures in reaches, or collections of reaches, as follows:

Mosher Slough: In Mosher Slough, the Corps would use cutoff walls and levee raise as needed for sea level rise protection.

Delta Front (Shima Tract, Fivemile, Tenmile, and Fourteenmile Sloughs): In these reaches, the Corps would install cutoff walls and place erosion protection on west facing slopes. Seismic protection would be applied to Fourteenmile, and portions of Fivemile and Tenmile Sloughs. Slope reshaping would be used in all of Tenmile and portions of Fourteenmile Slough. Fourteenmile Slough would have a closure structure where it meets the westernmost extent of the delta front levees. In the portion of the project along Fourteenmile Slough where a setback is proposed as part of a conservation measure, seismic remediation measures would be constructed landward (west) of the setback from the slough, and a new levee will be constructed there. The old levee would be partially degraded. The land between the new and old levees would become a mitigation area for project impacts. The setback width would be 60-90 ft, and would occur within reach FM_30_L.

Smith Canal: A closure structure would be installed between Brown's Island and Dad's Point, and a short berm (considered new levee) would be built from the southern portion of Dad's Point to Louise Park.

Calaveras River: Cutoff walls and some slope reshaping would be used for both banks between the San Joaquin River to as far east as Cherryland Avenue for the north bank and the Stockton Diverting Canal for the south bank. The extent of this work is reduced in Alternatives 7 and 9 compared to Alternative 8 (see Alternatives, below).

French Camp Slough: Cutoff walls would be installed on the north levee between the mouth at the San Joaquin River east to I-5 (includes part of Walker Slough). Specific sections of this reach have been repaired by RD 404 and are excluded from the proposed project.

Stockton Diverting Canal: Cutoff walls would be installed in the entire south levee between old Mormon Slough and the Calaveras River.

Mormon Channel: Work in this reach involves a control structure and other work, as described above (see Structural Measures).

San Joaquin River: Cutoff walls would be installed on the right bank levee of the San Joaquin River from Burns Cutoff extending south and east to the north bank of French Camp Slough near Horton Avenue, and on a separate section from 2,100 ft upstream of the Calaveras River to the Smith Canal Closure Structure (this latter section would also be raised). Some slope reshaping would also be done in Burns Cutoff.

Duck Creek: For several alternatives, about a mile of new levee would be built between about Interstate Highway 5 to Odell Avenue. Between Odell and McKinley Avenues, the levee would be reshaped, raised as needed, and a cutoff wall would be installed.

RD 17: This element involves various measures applied to levee sections bordering RD 17, beginning at the left (south) bank of French Camp Slough 600 ft southeast of Carolyn Weston Boulevard, continuing south along the right (east) bank of the San Joaquin River to Lathrop Road, and turning east at the southern end of the existing tie back levee. It involves cutoff walls along the south bank of French Camp Slough. Along the mainstem San Joaquin River, plans call for a large section of cutoff walls and/or slope reshaping, significant sections of seepage berms, levee reshaping, levee raise for certain sections near Stewart Tract, and a new setback levee section with erosion protection in the vicinity of Old River. For the southernmost, east-west dryland section of levee, this levee would be extended east by a new levee section, the existing levee would be raised, and both existing and new levees would also receive erosion protection.

The alternatives include a No Action alternative (Alternative 1), and six action alternatives consisting of implementing different combinations of the work elements as described below:

Alternative 1: No Action. Under this alternative, the Corps would not participate in flood risk management.

Alternative 7a: Delta Front, Mosher Slough, Lower Calaveras River (both banks to El Dorado Street), Smith Canal, San Joaquin River, French Camp Slough, and Duck Creek. This is the Corps' preferred alternative or "tentatively selected plan." Table 1 summarizes the work elements in this alternative, and the locations are shown in Figure 1.

Alternative 7b: Delta Front, Mosher Slough, Lower Calaveras River (both banks to El Dorado Street), Smith Canal, San Joaquin River, French Camp Slough, and RD 17.

Alternative 8a: Delta Front, Mosher Slough, Lower Calaveras River, Stockton Diverting Canal, Smith Canal, San Joaquin River, French Camp Slough, and Duck Creek.

Alternative 8b: Delta Front, Mosher Slough, the Lower Calaveras River, the Stockton Diverting Canal, Smith Canal, San Joaquin River, French Camp Slough, and RD 17.

Alternative 9a: Delta Front, Mosher Slough, less work on the Lower Calaveras River (north bank terminating at North Pershing Avenue, south bank terminating at about I-5), Smith Canal, San Joaquin River, Mormon Channel, French Camp Slough, and Duck Creek.

Alternative 9b: Delta Front, Mosher Slough, less work on the Lower Calaveras River (north bank terminating at North Pershing Avenue, south bank terminating at about I-5), Smith Canal, San Joaquin River, Mormon Channel, French Camp Slough, and RD 17.

PROPOSED PROJECT

The construction work for the Corps' preferred alternative 7a consists of flood protection improvements to 24 miles of levees in the the north and central Stockton areas. The purpose of this work is to address seepage, slope stability, overtopping, and erosion concerns of levees adjacent to urban areas. Construction is proposed on Mosher, Tenmile, Fivemile, Fourteenmile, and French Camp Sloughs, the San Joaquin and Lower Calaveras Rivers, Duck Creek, and Shima Tract. A set of treatments and combination of flood control measures will be done to improve levees depending on specific location, including 20.1 miles of cutoff walls, 6.1 miles of geometric improvement (slope and crown reshaping), 3.5 miles of levee raises, 3 miles of seismic protection, 4.9 miles of erosion protection, two closure structures encompassing several acres total, and 0.95 mile of new levee[1].

[1] Quantities are approximate lineal distances; work width and total area of work vary with location and depend on levee height and other factors. The floodwall now to be substituted with a berm is considered new levee.

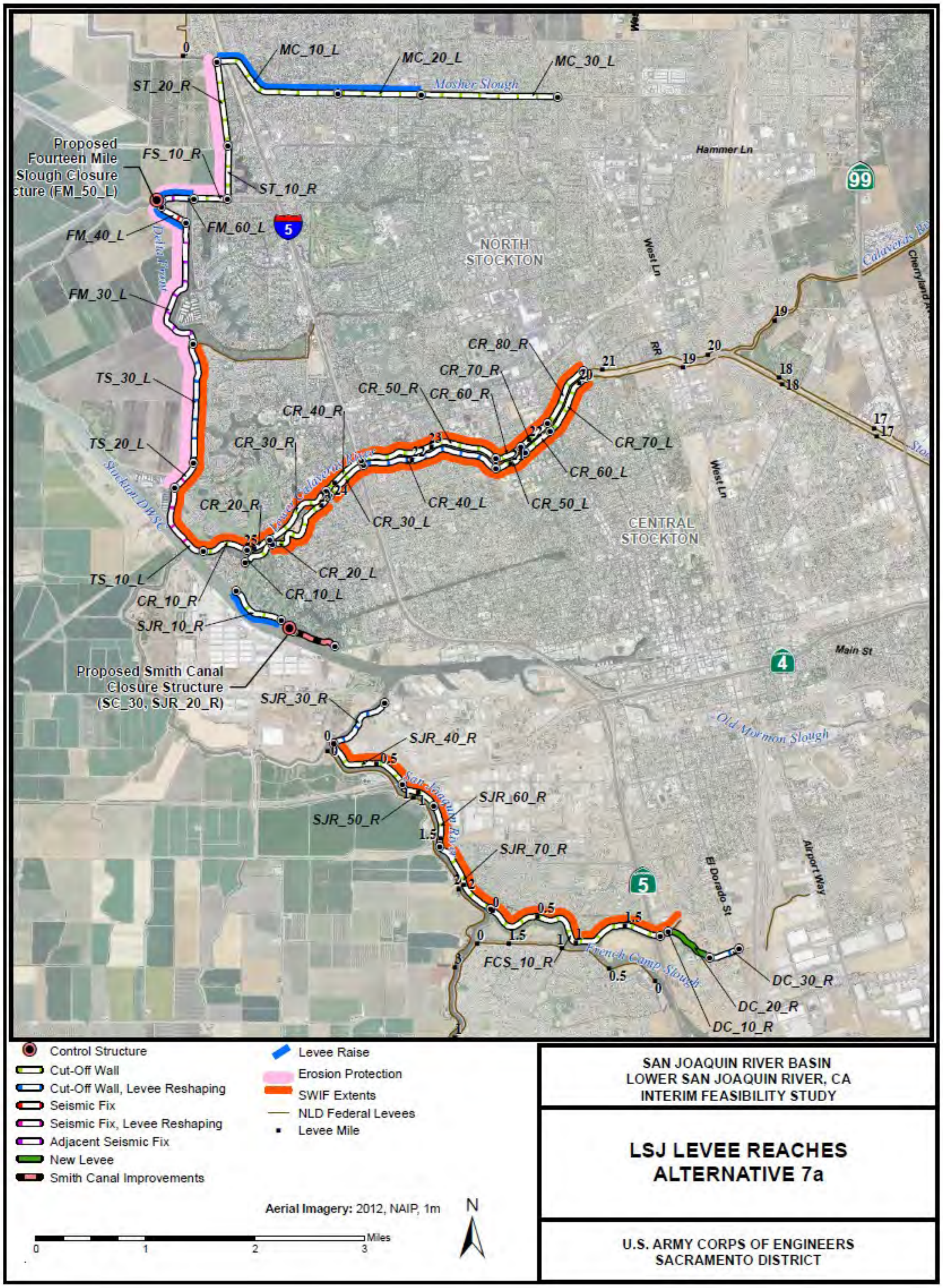
Table 1: Proposed measures by location, from north to south, for the tentatively selected plan (alternative 7a) of the Lower San Joaquin River Feasibility Study.		
Waterway	**Reach**	**Proposed**
	North Stockton	
Mosher Slough	Thornton Road to UPRR railroad tracks	Cutoff wall
Mosher Slough	Shima Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)
Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection
Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection
Fourteenmile Slough	Fivemile Slough to proposed Closure Structure	Seismic Fix Slope Reshaping Levee height fix (sea level rise) Erosion protection
Fourteenmile Slough	Approximately 1,500 ft west of Fivemile Slough	Closure Structure
Fourteenmile Slough	Approximately 1,250 ft southeast setback out from proposed closure structure	Seismic fix Levee height fix (sea level rise) Erosion protection
Fourteenmile Slough	From setback cut south to Tenmile Slough	Seismic fix Adjacent levee slope reshaping Erosion protection
Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope reshaping Erosion protection
Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic fix Slope reshaping Erosion protection
Tenmile Slough/ Buckley Cove Marina/ San Joaquin River	West March Lane/ Buckley Cove Way to Calaveras River	Seismic fix Slope Reshaping
Calaveras River – Right/ North Bank	San Joaquin River to North El Dorado Street	Cutoff wall

Table 1, continued		
Waterway	**Reach**	**Proposed Measure**
	Central Stockton	
Calaveras River – Left/South Bank	San Joaquin River to approximately I-5	Cutoff wall
Calaveras River-Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping
Calaveras River – Left/South Bank	Approximately North Pershing Avenue to approximately El Dorado Street	Cutoff wall
San Joaquin River	From approximately 2,100 ft upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)
Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure structure
Smith Canal	Dad's Point from the closure structure to approximately375 ft down Monte Diablo Avenue	Short berm (new levee)
San Joaquin River	Railroad Bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping
San Joaquin River	Burns Cutoff to French Camp Slough	Cutoff wall
French Camp Slough – Right/North Bank	French Camp slough confluence with the San Joaquin River to approximately 500 ft southwest of I-5	Cutoff wall
Duck Creek	500 ft past I-5 crossing to approximately Odell Avenue	New Levee
Duck Creek	Approximately Odell Avenue to McKinley Avenue	Cutoff wall Levee Reshaping Levee height fix

Vegetation ETL requirement: The Corps has determined that a vegetation free zone (i.e., no woody vegetation, grasses and forbs only), as required by the Corps' Engineering Technical Letter 1110-2-571 (ETL), would be established for all elements of the project at the time of construction of flood features in each reach. However, the ETL includes a variance request process whereby vegetation may be permitted in certain portions of the levee profile if in depth engineering analysis shows that it would not cause a risk to flood protection features. This engineering analysis has not yet been done for any part of the project. As part of the ESA consultation with the Service, the Corps used its preliminary judgement to estimate the outcome of a variance request. For this project, the Corps would establish a vegetation free zone that extends normally from 15 ft landward of the levee over the crown, and encompasses the upper half of the waterside slope.

For the lower half of the waterside slope, from the midpoint of the levee to 15 ft waterward of the levee toe, the Corps has assumed a variance would be approved which would allow between 25 and 50% of the existing vegetation to remain in that zone. This would not necessarily be in

Figure 1. Lower San Joaquin River Feasibility Study Recommended Plan



the same form, height, or species composition, as the current vegetation. Specifically, large diameter trees, some non-native trees including nut trees, and brambles and vines, would be completely removed. Remaining and future vegetation will be limited by basal or stem diameter to be decided, but probably on the order of 8 to 12 inches at most. While variance areas may have some allowances for vegetation, these areas still may be subject to other forms of maintenance such as mowing or grouting. The Corps will establish an operation and maintenance manual which define these maintenance needs and vegetation limitations, and the required routine measures to maintain these vegetation free and variance zones.

Operation and Maintenance (O&M): To establish, reestablish, or maintain the required O&M and inspection road on the landside of the levee, the Corps has determined for this project that trees and shrubs would be removed from the landside levee from the levee toe approximately 20 ft landward on new levees and between 10 and 20 ft on existing levees, consistent with existing O&M agreements (i.e., O&M can exceed the ETL requirement). This O&M easement, and the vegetation ETL requirement zones described above, would be maintained clear of trees and shrubs, or within limits described for variance areas, through routine O&M (up to four times per year). The areas would be regularly mowed, animal holes grouted, and subject to inspection and various forms of repair for any deficiencies.

Borrow Areas: The estimated area of disturbance to obtain materials for the proposed work ranges from 132-461 acres. Specific locations have not been identified, however, the source is most likely to be fallow lands or agriculture.

Staging: Additional areas of disturbance would also be involved in construction for staging. There is no information on the locations or estimates of area at this time.

Mitigation: In its February 2015 DEIS/R, the Corps stated that compensatory mitigation would be used to mitigate for project impacts but did not include a mitigation plan for all impacts, and a plan was still not available at the time of the writing of this report. The Corps is at least required to compensate for effects to listed species as described in the Service's biological opinion, by purchase of 123 conservation credits for delta smelt and 37.76 credits for giant garter snake, and by planting 196 elderberries and 196 associated plantings in the setback area on Fourteenmile Slough (Service 2016). As explained later in this report (see Discussion), such credit purchase is one acceptable option but not necessarily the Service's preferred form of mitigation for all species or habitats. NMFS (2016) stated that 19,630 ft of Shaded Riverine Aquatic (SRA) cover habitat would be affected by the preferred alternative. This SRA cover may necessitate separate compensation to offset impacts to listed anadromous fishes, however, amounts and locations are not known at this time. Beyond listed species impacts and compensation, the Corps estimates that there are 139 and 10.75 acres, respectively, of riparian and wetlands impacted by the recommended plan. It is not yet known how these effects on riparian, wetland, and SRA cover types would be mitigated.

EXISTING BIOLOGICAL RESOURCES

Vegetation:

Existing resources were examined during site visits to the project area by Service staff on May 29-30, 2013, and January 7, 2016. Our examination of the project area was limited to brief visual inspection of a few representative locations of each project reach at most. As such, our discussion in this report is not intended to be comprehensive or quantitative. The Corps developed an estimate of the areas of cover types within the impact area of potential elements of the project using Google Earth, in which the impact boundaries were laid over satellite aerial photography. The impact area was divided into polygons of various cover types which were summarized in tables. The Corps provided this information to the Service on April 30, 2014 and it has not been updated since. Previously (March 1, 2011), the Service also participated in a more extensive site visit of RD 17, including most - but not all - of the areas included in the RD 17 element proposed in this study. Notes and photographs by Service staff from the site visits were used to grossly evaluate the type and quality of resources present. Below, we first describe the vegetation, then the cover types, for the project area.

Although much of the vegetation in the project area is in a highly altered and fragmented landscape, it is a large area (~676 acres, all elements combined; ~24-53 levee miles affected by construction, depending on alternative), and varies considerably with location and even within a levee segment, as summarized below.

Mosher Slough is a drainage on the northern border of the project that connects to Bear Creek to the north, is tidally influenced, and has partially perennial water (west of the confluence of Little Bear Creek). There is a dense tree canopy to the west of Don Avenue, encompassing about half the work on this reach, but only scattered trees to the east. The trees are a mix of natives and non-natives.

The Delta Front section of the project includes, from north to south, levees on Shima Tract, Fivemile Slough, Fourteenmile Slough, and Tenmile Slough. Wetland vegetation margins were seen during the site visit wherever soil and standing water occurred, including the dryland levee area of the Delta Front, but usually not when there was a rock riprap toe, which was the much more common condition.

On Shima Tract, there are occasional large trees scattered on both the land and water sides of the impact areas. The land side has a series of basins with wetland vegetation that extends about 0.7 miles south to Hammer Lane, that appear to function as part of an irrigation system to serve agriculture to the west. The rest of this levee length exhibits little if any riparian or wetland vegetation. Wetland plants are relatively uncommon, although there are some patches (up to ~1000 square ft) to the west. The Fivemile Slough levee work is an east-west section bordering the slough with this name. Based on the site visit, this appears to be a relatively unvegetated levee although we did not examine it in detail.

Fourteenmile Slough is the major waterway connecting the Delta to the project area. The levee work is proposed for the west facing section of the levee which borders this slough before it turns east into north Stockton. The margin of this slough where the work is proposed is riprapped, with wetland vegetation in the forms of floating fragments of water hyacinth and rooted emergent vegetation. Emergent aquatic vegetation becomes increasingly prominent near Village West Marina, and there are much larger areas of such vegetation within the waterway in the section which turns east as it enters greater Stockton. Virtually all of this vegetation is outside the work footprint, but is in the area to the east of the closure structure that could be affected by its operation. The levees east of the closure structure are also heavily rocked but have occasional individual trees, perhaps saved by local ordinances, and plantings associated with encroachments (e.g., gardens, boat docks). The west face has upland and shrub vegetation, and at least portions with a ditch and wetland vegetation outside the levee toe.

Tenmile Slough is the next levee section to the south. The levee slopes are a mix of granular rock surface, shrubs, and annual grassland cover, depending on location. There is a significant amount of shrub on or near the lower half of the west slope, including a few elderberry shrubs. Where it borders agriculture, there is a ditch with intermittent or continuous water on the water side that would be relocated with the project. The observation of duckweed in our first visit (May 29-30, 2013), suggests there are at least sections where water is perrenial. Farther south, past March Lane, this levee borders the San Joaquin River in a marina area known as Bulkley Cove; patches of emergent aquatic vegetation and more water hyacinth fragments are present.

The Calaveras River areas where work could occur also vary in habitat quality and vegetation type with location. Habitat is impaired near the mouth by rock riprap and for the first mile or so east of the mouth by boat docks. However, there is significant woody vegetation on the bank slopes, and on islands and land areas between the levees. Additionally, upstream to around Pershing Avenue, there is significant wetland vegetation in backwaters and other shallow areas with this woody vegetation. East of Pershing Avenue upstream to the Stockton Diverting Canal, the habitat character changes to a narrower channel with little emergent or woody vegetation, surrounded by a wider expanse of annual grassland, all within the levees. This condition is likely the result of routine channel maintenance.

Smith Canal was not examined, however, aerial imagery seems to indicate that it supports urban vegetation in the form of large individual trees, most of which are growing in or near the levee which rings the canal. It also has a significant number of boat docks and other structures throughout its length except for a park at the eastern end (American Legion Park).

The relatively barren appearance of the Stockton Diverting Canal in aerial imagery, typed as ruderal, is consistent with the limited ground observations made during the site visit; although there were native and non-native trees adjacent to the canal (a Swainson's hawk was observed landside near such trees during the site visit). However, there are often urban trees on the landside near enough to the levees that they would be affected by construction. These trees may be used by wildlife such as hawks, which forage in the predominant dry portions of channels.

Mormon Channel has some significant vegetation in sections with mature oaks and other understory riparian species, mainly between South Wilson Way and the Stockton Diverting Canal. Further west, the vegetation is sparse up to Commerance Street; west of which the vegetation becomes thicker again, possibly supported by the charging of groundwater by tidal influence.

The vegetation along the San Joaquin River and French Camp Slough, including RD 17, is variable. There is more abundant woody riparian along the waterside of the levees of French Camp Slough, particularly the left (south) bank. Although much of the north bank levee, which is included in the Corps' preferred alternative, appears maintained and partially riprapped, it supports a significant albeit narrow margin of vegetation at the toe of the levee. More riparian and wetland vegetation is present just beyond the levee toe but within the waterside easement zone. Vegetation on the land sides of both north and south levees is also present to varying extents, either urban or associated with a golf course.

Woody vegetation is much less frequent along the mainstem San Joaquin (both the San Joaquin and RD 17 elements) primarily because the levees, which are heavily rocked, form the land-water margin interface and do not provide a substrate for establishment. The vegetation which is present is limited and occurs in various forms: isolated trees or shrubs (or small groups) on the levee or at the land-water interface; shrub-scrub on levees sections that may be less vigorously maintained; limited groves of large trees on the landside (valley oak, in RD 17); and portions where the levee is set back a modest distance from the river, creating a riparian berm or oxbow (cottonwood riparian, in RD 17 and French Camp Slough). These berm areas in RD 17 are relatively infrequent and discontinuous, but could provide important fish and wildlife values due to the location. A significant quantity of this remaining vegetation is within the impact footprint, particularly within the San Joaquin River, RD 17, and Mormon Channel elements.

<u>Wildlife:</u>

In urbanized areas, the impact areas are often riprapped and bordered by homes or other developments on the landside, with occasional trees at most. The adjacent waterside habitat varies with location - it can be a dry maintained floodway, open water, or open water with nearby marsh vegetation. These areas often lack ground cover or a soil layer. The most likely wildlife to occur there are those adapted to human disturbance such as house sparrow, house finch, rock pigeon, mourning dove, American crow, gulls, Norwegian rat, raccoon, and opossum. Great egret, great blue heron, and a number of species of ducks and other waterbirds would be expected in and near wetlands or other waters in the project area.

Where there is remnant forest or shrub cover, a much wider variety of wildlife can be expected, including birds such as acorn woodpecker, black phoebe, house wren, oak titmouse, western kingbird, yellow warbler, and spotted towhee, and mammals like beaver, cottontail rabbit, and (rarely) the listed riparian brush rabbit - which is known from locations of RD 17. Raptors such as the Swainson’s and red-tailed hawk would be expected to be present where there are mature trees adjacent to agricultural lands (RD 17, Mormon Channel), or urban trees adjacent to maintained dry floodways (Stockton Diverting Canal).

Fisheries:

Fish diversity and abundance in the project area depends on permanence of water, and tidal influence. In the nontidal urbanized waters to the east, one would expect introduced species such as mosquitofish, catfish, and carp, and perhaps a few others. In the tidal areas, including all of the sloughs and mainstem San Joaquin River, a much greater variety of fish species, both native and non-native species, are likely to be present. The San Joaquin River, its tributaries, and sloughs, are considered a major migration corridor for important anadromous species, and can also provide rearing habitat for these species. Species of major significance include fall-run chinook salmon, delta smelt, Sacramento splittail, and white and green sturgeon. Many other native and nonnative species are also likely present in the tidal waterways, including catfish, black bass, sunfish, and minnow species.

Endangered Species:

Under the ESA, the Service has consultation responsibility for species other than anadromous fishes and marine mammals, which are the responsibility of NMFS. Of these, there have been recent sightings of the endangered riparian brush rabbit in portions of RD 17. Elderberry occurs within portions of the impact area of the project in a number of locations (often as individual shrubs within the levee cross-section), and is the host plant of the threatened valley elderberry longhorn beetle - whose range includes the project area - with nearby records on the Calaveras, Cosumnes, Middle, San Joaquin, and Stanislaus Rivers. The threatened giant garter snake is also known from the project vicinity, with nearby records on the Stockton Diverting Canal and Pixley Slough, among other locations. All of the listed fishes, including delta smelt, are considered to be present in the mainstem San Joaquin River and adjacent waters that are part of the proposed project, as indicated in their occasional occurrence in sampling records over the long term. The Corps has completed consultation with the Service and National Marine Fisheries Service (Service 2016, NMFS 2016).

Cover types, Resource Categories, and Mitigation Goals:

The Service's Mitigation Policy (Policy) (FR 46:15 January 23, 1981) provides general guidance in making recommendations to conserve fish and wildlife resources. Under the Policy, resources are assigned to one of four Resource Categories, with a mitigation goal consistent with the values provided to fish and wildlife and the rarity of that habitat (cover type). A mitigation goal is assigned ranging from "no loss of existing habitat value" (Resource Category 1) for the most valuable kinds of habitat, to "minimize loss of habitat value" (Resource Category 4) for the less valuable and most common kinds of habitat. Application of the Policy involves designating cover types which may be affected, and assigning evaluation species based on the sensitivity of those species to the project action, their role in the ecosystem, or association with Service-wide resource management issues such as anadromous fish and migratory birds. We then state the Resource Category, the rationale for that selection, and the corresponding mitigation goal.

Oak woodland: This cover type is characterized by an overwhelming dominance by oaks, usually valley oak, with other species like box elder, blue and live oak, and black walnut as associates. Understory can be grass only, or include shrubs like poison oak and wild grape. It provides important resting, nesting, cover, and forage functions for deer and squirrels, and is especially important in the project area for birds like the red-shouldered hawk, which would be an evaluation species. It is present in groves near RD 17, the old Mormon Slough channel, and in portions of French Camp Slough which could be affected by the project. Due to the importance of oak woodland to the evaluations species and limited extent in the project area, we designate it Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Riparian Forest: This cover type is characterized by an overstory which is often dominated by cottonwood, and which includes other species like California sycamore, valley oak, box elder, and Oregon ash; the understory includes willow species, grape, wild rose, blackberry, poison oak, and elderberry. Riparian forest supports a relatively high diversity of bird and mammal species, including woodpeckers, squirrels, rabbits, towhees, salamanders, and others which utilize different layers and niches within the forest. It is present in the project area in the forms of sporadic patches or individual trees throughout the project area at the levee toe, and on waterside berms or oxbows, where these exist, such as in RD 17, French Camp Slough, Calaveras River, and Mosher Slough. Appropriate evaluation species reflecting this use would be the downy woodpecker. Due to the importance to the evaluation species and limited extent in the project area and region, we designate it Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Riparian Scrub-shrub: This cover type consists of smaller stature woody species, frequently less than two meters in height. Shrub-scrub in the project area is often dominated by willows with a significant component of Himalayan blackberry. This can support a range of wildlife but not birds or species such as woodpeckers or hawks that depend on larger mature trees for forage or nesting. Individual elderberry plants are a component of scrub-shrub in the project area, often within the existing levee (e.g., RD 17 south of Weston Boulevard; Dos Reis Park). The riparian scrub-shrub in the project area supports two listed species, the endangered riparian brush rabbit - which has been documented in the RD 17 element, and the threatened valley elderberry longhorn beetle - which was last documented in the region in a 1984 sighting along Middle River, near the project area. An appropriate evaluation species which uses this habitat would be the yellow warbler. Due to the importance to the evaluation species and limited extent in the project area, we designate riparian scrub-shrub as Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Annual Grassland: This cover type consists exclusively of annual grasses and, in the project area, is dominated by common grasses like ripgut brome, foxtail barley, weeds such as yellow starthistle and Italian thistle, and others. It is present on levee slopes and adjacent land side and water side areas throughout the project area that are not rocked, as well as within the upper portions of the Calaveras River and Stockton Diverting Canal floodways, which are dry outside of the flood season. Much of this area is subject to regular mowing as a maintenance and fire control activity, as well as grouting of animal holes. These areas do have wildlife value such as to foraging hawks, and their prey such as the California vole, which could serve as an evaluation species. However, this cover type is relatively common in the region. Due to this abundance, we designate it Resource Category 4, with a mitigation goal to minimize loss of habitat value.

Orchard: This cover type consists of fruit or nut trees, and is present in the impact footprint of the Mormon Channel bypass element. It does have value to some common mammals and bird species, although generally not to hawks. This cover type is locally common in the planning area, and provides somewhat different values to wildlife than annual grassland. Scrub jay would be an appropriate evaluation species. Considering its importance and abundance, we designate orchard as Resource Category 3, with a mitigation goal of no net loss of habitat value, while minimizing loss of in-kind habitat value.

Wetland: This cover type occurs in or near permanent or temporary waters, and features wetland plants such as cattails, tules, and others. It provides cover and forage for songbirds associated with wetlands such as the tricolored and red-winged blackbirds, as well as wading birds like the great egret, which would serve as an evaluation species. It is sporadically present in the impact area of the project; in or near the margins of ditches, sloughs, and other waterways, usually as small-to-moderate sized patches or thin strips wherever there is an intersection of soil with shallow water. It is present in varying amounts in the planning area. The largest wetlands are east of the proposed closure structure on a portion of Fourteenmile Slough, with significant amounts of wetland in French Camp Slough, portions of the Calaveras River, and Duck Creek. Some wetlands are also present in portions of irrigation ditches bordering the west side of the delta front levees, and in what appears to be irrigation delivery system ponds located just east of the northerly Shima Tract levee. Elsewhere limited fragments of wetland vegetation exist on Mosher Slough and the San Joaquin River. Due to the importance to the evaluations species and limited extent in the project area, we designate wetland as Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Shaded Riverine Aquatic Cover: Shaded Riverine Aquatic Cover (SRA cover) is defined as the zone of interface of water with the land margin, projected over the water to the maximum extent of overhead vegetation. The habitat value within the SRA cover zone varies with factors such as water depth, overhead cover from nearby riparian trees, instream cover elements such as wood, boulders, and submerged vegetation, and the type of aquatic substrate. SRA cover is considered essential habitat to a variety of fish species, and is used as cover, forage, spawning, and rearing habitat for fishes, both anadromous species and resident native and nonnative fishes. It also provides habitat for birds such as the kingfisher. An appropriate evaluation species would be the chinook salmon, for which evaluation models for SRA cover are available. SRA cover is extremely limited in the project footprint as well as the region, the result of clearing and bank protection from prior flood control, urban development, and/or navigation projects. Due to the vital importance to the evaluations species and very limited extent in the project area, we designate SRA cover as Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Tidal Open Water: Tidal open water is defined as unvegetated, permanently inundated areas, typically below MLLW, that are at a low enough elevation to exhibit tidal cycles. It is represented in the project area by the areas east of the proposed closure structures on Fourteenmile Slough and Smith Canal, which could be affected by gate operations, and other sloughs and waterways which are unaffected. Tidal open waters in freshwater systems such as these provide habitat for resident and migratory native and non-native fishes, including native and non-native species. These areas can provide rearing habitat for juvenile fish, although the quality of that habitat may be impaired by predatory fish and physico-chemical factors during some seasons. Tidal waters in the project area also have ecological functions of contributing to the tidal prism that sustains the salinity gradient in the delta, and distributing forage organisms and detritus. Since these functions are general, we have not assigned an evaluation species. However, tidal waters are very limited in extent in the project area, and have been affected by adjacent development such as docks and other structures and the input of chemicals from urban drainage. Due to the general importance to all species in the Delta, and limited abundance in the project area, we designate tidal open water as Resource Category 2, with a mitigation goal of no net loss of in-kind habitat value.

Urban landscaping: Urban landscaping is a term applied to trees which are planted in or near residences, golf courses, parks, and other developed grounds. These are typically non-native species or varieties of native species which are obtained from nurseries for shade and aesthetic values. There is urban landscaping near as well as within the project footprint in residential areas, where some plants have been placed within the maintenance zone of existing levees, including the cross-section of the levee itself (considered encroachments). Urban landscaping can have wildlife value particularly when, as here, it is in proximity to other cover types like annual grassland or riparian forest or scrub, and open water. We do not typically designate evaluation species or a mitigation goal for urban landscaping, which is abundant in the planning area. Rather, the Service would recommend mitigation consistent with either State or local ordinances governing removal and replacement of this type of vegetation[2].

Agriculture: Agriculture exists in the form of row crops in portions of the project footprint, and in the RD 17 and Mormon Channel elements. These are harvested regularly, leaving fallow, tilled ground. This cover type provides forage and habitat for ground-dwelling small mammals like the California vole, which are prey items for hawks; either of which can serve as evaluation species. It is common in the planning area and region, so we designate it Resource Category 4, with a mitigation goal to minimize loss of habitat value.

Disturbed Areas: This term is used to encompass other areas that lack vegetation and/or are so frequently disturbed as to have minimal or no resource value. It would include the upper rocked faces of levees (outside of any actual or potential SRA cover), roads whether paved or not, structures (homes, boat docks), and manicured lawns and shrubs. These areas do not have an evaluation species or mitigation goal.

FUTURE WITHOUT THE PROJECT (NO-ACTION ALTERNATIVE)

Under the no-action alternative, the various deficiencies in the project levees would remain. ETL non-compliant vegetation would probably remain, including native and non-native shrubs, trees, and other cover in and near the various levees. The future in RD 17 without the project would depend on whether or not separate action is taken to improve those levees, such as with the proposed Section 408 project for phase III. If the RD 17 phase III project were not built (by

[2] For example, if the State or local ordinance specified equal replacement of trees greater than 3-inches on the basis of 1:1 diameter at breast height, such that a 3-inch tree is compensated by the planting of three, one-inch saplings, the Service would recommend the same. Such policies/requirements have not been researched at the time of this final report.

either the Section 408 project or the feasibility study), planned expansions of the Cities of Stockton and Lathrop would likely not occur. Under this scenario, the habitat conditions would remain as current, with relaxed maintenance of the existing levees, allowing limited shrub-scrub, oak woodland, and riparian forest. The adjacent landscape would continue as annual grassland or agriculture. If RD 17 phase III were built separately, it would have similar effects to the RD 17 element of the feasibility study (see Future With The Project, below).

Habitat conditions in the waterways of the project are likely to change over the life of the project due to climate change, which will result in sea level rise and regional changes in the timing of precipitation and runoff. Changes in average water depth with sea level rise could affect the distribution of wetland vegetation, possibly reducing the extent of it in French Camp Slough and the Calaveras River near the confluence, and possibly in Fourteenmile Slough as well. Tidal waters may extend farther inland in all of the sloughs. Depending on the rate of sea level rise and vegetation allowance, it may be possible for marsh to accrete organic matter fast enough so that it keeps pace with sea level rise. Other consequences of sea level rise are likely, such as decisions affecting operations and new facilities for water export. This could in turn affect the salinity distribution and other water quality factors throughout the Delta, but the precise effects in the project area are uncertain at this time.

FUTURE WITH THE PROJECT

The future with the project is presented in this report in several ways: (1) description of the effects of the project on individual work elements, or similar groups of elements based on examination of aerial imagery and calculations provided by the Corps; and (2) a semi-quantitative evaluation of the amounts of habitat loss, also provided by the Corps, for the elements that form the alternatives (Table 3; Corps 2015a). We have not conducted ground verification of these impacts, nor can we judge the habitat quality factors beyond gross vegetation stature as revealed by aerial images and limited direct observation and ground photographs. Information not available at this time includes the amounts of annual grassland and developed areas in each of the work sites, the amounts of temporary and permanent impacts on all vegetation types, and the types and locations of mitigation for impacts to woody and wetland vegetation types.

In all of the affected footprint areas, we assume the levee slopes and easements would be maintained, free of vegetation on the landside slope and easement, crown, and upper half of the waterside slope, and that an ETL variance would permit at least 25% of the current vegetation to remain on the lower half of the waterside slope. This future is also described in our Biological Opinion and is considered a reasonable worst case scenario. The eventual variance allowance on the lower waterside slope is expected to vary from 25-50%. The impact estimates in the descriptions below for the elements of the preferred alternative were done assuming this worst-case scenario with a variance and apply only to those elements which are included in the preferred alternative (from Service 2016, Appendix B). The impact quantities discussed in this report for the additional elements in the other alternatives (Stockton Diverting Canal, Mormon Slough, RD 17 including the French Camp Slough south bank) have not been adjusted to consider a minimum variance allowance and are based on the Corps DEIS/R (Tables 5-38 and 5-40 *in* Corps 2015a) . Although a variance would have net impacts to the quality and quantity of riparian vegetation, there could be some benefits, such as reduction in non-native plants, creation of canopy openings that would provide basking habitat for reptiles such as the listed giant garter snake, and providing opportunity for recruitment (or planting) of elderberry, which is the host plant of the listed valley elderberry longhorn beetle. Nevertheless, a general reduction in habitat values is expected with the project, related to the reduced height and width of riparian zone associated with ETL variance limits, which effects not only terrestrial wildlife use, but also inputs of wood and organic matter to the adjacent waterway that supports aquatic species. Burrowing animals would be affected by increased grouting activity which would include variance areas - thereby reducing refugia for reptiles such as the giant garter snake.

Mosher Slough: Levee raise and cutoff wall construction in this reach is expected to impact about 4 acres of woody riparian on the waterside slope and easement, and about 18 acres of woody vegetation on the land side. This would be a significant loss within this particular area, which is about half of the length of the levee work. This loss includes a number of moderately large individual trees, 12 inches or more basal diameter, in the levee and easement profile that would need to be removed. The Corps has estimated a loss of 3 acres of wetland, however, we observed only limited wetland during a site visit to most of this reach, so actual losses are probably less than 3 acres. There would also be a temporary impact to roughly 20-30 acres of annual grassland. The levee toe is undercut at least in portions of the western 1/3-1/2 of this levee which have woody vegetation. With a variance, vegetation would be thinner in this reach downstream, and possibly slightly thicker upstream. The quality of any allowed vegetation would be reduced, due to limitations on size, but some aspects of habitat quality may improve due to the removal of non-natives, and opening of the canopy - which could promote wetland vegetation as depths allow.

Delta Front: The vast majority of the western front work within Shima Tract, Fivemile Slough, Fourteenmile Slough, and Tenmile Slough, and in the footprint of the closure structure appears to be mostly either bare ground (some with granular rock surface) and ruderal upland vegetation, with scattered individual shrubs and trees. All of this vegetation would be removed and the levee face covered with rock riprap. The westward irrigation ditch and associated wetland vegetation, where present, would be temporarily impacted but would likely be replaced and recover to similar habitat quantity and quality as preproject. It is assumed that the waterways and wetland vegetation to the east of the levees (unless within easements) would not be affected. The Corps has estimated losses of 31 and 4 acres of woody vegetation and wetland, respectively. We could not confirm the extent of woody vegetation during our site visit. It is possible that these areas are low scrub, have recently changed since the imagery, or that some areas were mistyped based on aerial imagery. Another 30-40+ acres would be impacted, of which perhaps 20 acres at most is annual grassland, and the rest is some form of developed or regularly disturbed ground (granular rock, riprap, paved or dirt road surface). The quality of the annual grassland varies; much is a thinly vegetated, regularly mowed surface, but some is higher and thicker growth. Estimated wetland losses could increase due to temporary ditch impacts that would be replaced, and possibly effects on wetland and/or woody vegetation where present in the easement area (e.g., Shima Tract).

With the project, the west slope would be covered with rock riprap. Habitat values would be eliminated on these rock sections. Other disturbed areas would be returned to annual grassland.

Subjecting these grassland portions of the levee and easements to Corps maintenance would only slightly reduce habitat values, because much of these levees is already heavily maintained.

Fourteenmile Slough and Smith Canal (including areas east of closure structures): The construction of the closure structures on both of these waterways will have modest direct effects in the footprint of the structures of several acres, and more widespread effects of operation throughout the ~233 acres of surface water isolated by the structures and adjacent waters (Service 2016). Tidal exchange is prevented when the gates are closed, which prevents normal fish movement for that period. The tidal prism, defined as the amount of water exchanged between low and high tide, will be incrementally reduced. Tidal flows distribute food organisms and detritus associated with the flows between the sloughs and connected waterways. These flows will be delayed and reduced by gate operation. Urban waterways such as these are typically used to receive runoff, which can include contaminants. These contaminants could become elevated and salinity reduced when the gates are closed.

Because the gate openings are relatively small (50 ft) compared to the width of the sloughs (300-900 ft), increased velocities will result at the opening, with relatively still adjacent water. This could result in increased predation during operation (NMFS 2016). The higher velocities might attract migratory fish when open, and then temporarily entrap them when closed. These effects will progressively increase in frequency and intensity over the project life as sea level rise requires more frequent operation. Depending on temperature and duration, dissolved oxygen could be measurably reduced during gate operation. Ecological processes related to natural tidal cycles, particularly the slack high tide which would be affected by the gate operation, include fish schooling behavior, bird feeding, and colonization by plants; all such processes will be affected in some fashion by gate operation. The gate structures and operations could also affect the movement and accumulation of fine sediment in the sloughs. With the project, the gates would permit encroachments to remain, including existing individual trees and boat docks. Boating and fishing activities would become increasingly regulated by gate operations as sea level rises and, in doing so, modestly reduce disturbance of fish and wildlife.

The setback area can at least be used to provide compensation for impacts to the valley elderberry longhorn beetle in accordance with our Biological Opinion (Service 2016). It could also potentially provide compensation for some of the values of riparian woodland and urban landscaping which needs to be removed, but not all of them. Specifically, the woodlands which are to be removed provide not only wildlife values, but also organic matter inputs that support resources in adjacent waterways. The wildlife values could be improved in some respects from the lost habitat by design and management to promote native plant species, and because the area would be less affected by the many disturbance factors associated with urban vegetation (i.e., human activity). However, while the setback area is adjacent to a waterway, it would be separated by the old levee which must be retained in order to protect the area in perpetuity from sea level rise. This separation will limit the interaction between the vegetation and the waterway, including inputs of organic matter to the waterway. Finally, the gate operations will adversely affect any floodplain benefits of the proposed levee setback area, because it is upstream of the Fourteenmile Slough closure structure.

Calaveras River (including Tenmile Slough south of the Delta Front work): A small amount of wetland might be impacted on the levee portion of Tenmile Slough which borders the Bulkley Cove marina, although this impact would be avoided if work is limited to the land side. For the preferred alternative, the Corps estimates effects in this area to total 12 acres of woody vegetation impacts on the waterside including easements, and 41 acres of woody vegetation, possibly including some urban landscaping, on the land side and easements. Removal of encroachments in the levee including boat docks and other structures would be needed on the lower reaches of this element, but boat-related recreation would not be otherwise restricted. The amount of waterside vegetation and hence the impacts, are less beginning east of North Pershing Avenue, and the effects are mostly on annual grassland and landside woody vegetation (probably urban landscaping). However, west of North Pershing Avenue, many of the trees are either on the upper half of slope and/or are larger than would be considered allowable with a variance. This means that the proposed project would remove nearly all woody vegetation in some locations. Some other habitat would remain untouched between the levees, including riparian terraces and shallow water wetlands that are inside levees and beyond easements, as well as a number of riparian islands. Within the levee profile and easements, the quality of any allowed vegetation will probably decline somewhat due to the limitations on size and density of vegetation. Impacts to annual grassland would be on the order of 40-50 acres, and largely temporary.

For alternatives 8a and 8b, which have continued work on the Calaveras River east of El Dorado Street to the Stockton Diverting Canal, impacts would increase to 58 acres of woody vegetation impact on the land side, with a substantially greater amount of temporarily impacted annual grassland.

Stockton Diverting Canal: This location would not be affected by the preferred alternative, but would experience effects in alternatives 8a and 8b. As reported by the Corps, imagery does appear to confirm that the bulk of the impact of work in this reach is on ruderal vegetation or disturbed lands, with occasional lost landside trees. The Corps estimates that there is 1 acre of woody vegetation impact on the landside. The waterside impacts are believed to be largely temporary in nature, and this vegetation would regrow after the work is done, asuming the same level of maintenance on the levee. Currently, this reach is heavily maintained by regular mowing, and limited, young woody vegetation occurs in a thin band along the low-flow channel of the canal.

Mormon Channel: This work element is included in Alternatives 9a and 9b only, and not the preferred alternative. As stated above, there is considerable mature vegetation in sections of this relict channel, and it is probably better described as riparian forest, oak forest and riparian scrub/shrub based on our limited ground observations during the site visit than “mixed trees and shrubs” as reported by the Corps, of which 10 acres would be impacted by channel improvements (almost entirely east of Highway 99). These estimated impacts should be considered minimums, as the thickness of this vegetation varies, and ground examination may reveal more may have to be removed for the bypass channel to convey the intended 1,200 cubic ft per second capacity than assumed based on the aerial images (i.e., west of Highway 99, where vegetation is also apparent in imagery). Of the impacts disclosed, the woody vegetation in these locations appears (both in satellite images and during the prior site visit) to be mature and of apparent high habitat quality in some areas (i.e., west of Walker Lane to Wilson Way), but of lesser quality west of Wilson Way. There could be some benefits if wetland habitat were enhanced in some way, or other restoration actions such as management of non-native herbaceous and woody species, were taken. By providing some peak flow relief, this work element reduces the need for impacts associated with the Stockton Diverting Canal work (i.e., in Alternatives 8a and 8b).

San Joaquin River: This work is common to all alternatives. From Burns Cutoff to French Camp Slough, there is limited vegetation on the waterside of the levee, but the project work would remove most (18 acres on both slopes and easements) of what little vegetation is left, because most of this length (a few miles) is completely rocked, and most of the existing vegetation is within the levee and easements subject to removal or reduction under the ETL.

French Camp Slough north bank and Duck Creek: There would be a significant amount of riparian vegetation affected by this work, mostly on French Camp Slough but also isolated trees on Duck Creek (total ~16 acres). Some of this appears to be land side golf course landscaping and, as with the Calaveras element, there would be a significant amount of unaffected riparian vegetation remaining between the levees. During the site visit, we observed trees not only adjacent to but, in some cases, within the existing levee profile.

RD 17 and French Camp Slough south bank: This work is not included in the preferred alternative, but is associated with Alternatives 7b, 8b, and 8b, and would affect a fairly long (~8+ mile) right bank section of the mainstem San Joaquin River and the more heavily vegetated left (south) bank of French Camp Slough bordering Weston Ranch. Based on aerial imagery and comparing DEIS/R Tables 5-35 and 5-36 (Corps 2015a), impacts would involve 35 acres of riparian on French Camp Slough, including numerous larger diameter trees within the profile of the levee and easement. Another 53 acres of riparian would be affected by the intermittent fixes along the mainstem San Joaquin River along RD 17. There are long sections with rock and either only occasional waterside trees or young riparian as the only vegetation, much of which are in the impact footprint of the work or levee easement where vegetation is subject to maintenance. We noted some such trees or shrubs were on the margin of the impact zone or within the waterside easements, but were not marked by polygons as having been impacted, so the impacts reported are probably a minimum. For the northern half of the work on the San Joaquin River in RD 17, from French Camp Slough to about Manila Road, this would result in removal of virtually all of the remaining woody vegetation. Most of the vegetation would be removed in the southern half of the element as well, although there would be some unaffected vegetation in the vicinity of the setback segment across from the Old River confluence, a few oxbows, and some other narrow waterside berms. In the east-west dryland portion of the levee work at the south end, impacts appear to be limited to ruderal vegetation and some agriculture (95 acres orchard/vineyard; 18 acres row/field crops).

If the RD 17 levees were improved, this would permit the near-term development of most of this adjacent land into residences and commercial/industrial structures; roughly 4,700 acres on which would be built 24,000 residences and about 800 acres of commercial property. This would include all lands up to the O&M easement of the improved levee. Habitat remaining after the RD 17 work would be limited to ETL compliant vegetation outside the O&M zones, probably very limited riparian on discontinuous waterside berms and oxbows. Wildlife would be at risk of disturbance from human activities, and movement between habitat patches would likely be impaired in that location. The outcome of formal consultation with the Service and NMFS under authority of the Endangered Species Act would ensure that any such project does not jeopardize the existence and recovery of any listed species and may include measures and/or other project alternatives to provide such assurance. Although the Corps has elected not to include RD 17 in its preferred alternative for the Feasibility Study, it requested initiation of formal consultation with the Service as a Section 408 project (letter dated February 27, 2015). We responded with a request for additional information (letter dated October 2, 2015) and are awaiting a response.

Comparison of Alternatives: Overall impact estimates in Corps (2015a) and other information provided to date suggest that the impacts in terms of habitat loss will be significant, reflecting the large scope of the project (~24 miles with the preferred Alternative 7a or 43-50+ miles of levees with other Alternatives)(Table 2). The amounts of loss for the preferred alternative 7a is less than other alternatives, and includes 139 acres of native woodlands, and 4-7+ miles of SRA cover, depending on the estimate. Alternative 8a has more impact due to additional work on upstream portions of the Calaveras River and to a minor extent on the Stockton Diverting Canal. Alternative 9a also has more impact due to effects on woody vegetation in Mormon Channel. Another ~80 acres and 22,000+ lineal ft of riparian and SRA cover loss, respectively, is expected for alternatives 7b, 8b, and 9b, due to RD 17 impacts. While we expect that Alternative 9a may have more impact than Alternatives 8a or 7a on woody vegetation due to effects on woody vegetation in Mormon Channel, these may be offset by (p. 4-12; Corps 2015a) "...ecosystem restoration benefits..." Such benefits are not explained nor quantified in Corps (2015a), but may relate to promoting other vegetation types and/or tidal functions, consistent with the flood control function.

DISCUSSION

Our 2014 draft report emphasized the need to develop better and more complete information regarding the quantities of effect that the proposed project would have on fish and wildlife resources. Some of this is provided in the DEIS/R (Corps 2015a), but it is still based on coarse aerial imagery. This imagery cannot discern the quality of the affected habitat, in terms of vegetation species, height, diameters, associated ground cover, plant number (in many cases), health, and other characteristics such as inundation frequency. Aerial imagery probably has some error in distinguishing woody and herbaceous vegetation and/or wetland vegetation. These characteristics are of importance to determining effects of the project and the need for and amount of mitigation. Additional ground-based study is warranted, at least for the alternative that is to be constructed.

No formal analysis was done by the Service or Corps to quantify changes in habitat value. This is a consequence of the limited information on existing conditions, lack of a mitigation plan, and schedule and funding constraints under the Corps' 3x3x3 guidance. Therefore, we cannot currently determine whether the project has met our mitigation goals for the more important resource categories being affected, including riparian forest, riparian scrub-shrub, SRA cover, wetland, and tidal open water.

Table 2. Existing vegetation (exclusive of herbaceous upland) within the composite project footprint of all action alternatives (Alternatives 7a, 7b, 8a, 8b, 9a and 9b). The footprint is comprised of the construction footprint, constructed features and easements required for operation and maintenance . The footprint does not include borrow sites, which have not been yet been specifically identified. Staging is assumed to occur within the footprint or on existing off-site developed lands. Vegetation numbers are in acres except for shaded riverine aquatic habitat (SRA), which is provided in lineal ft. Information is from the February 2015 DEIS/R (Corps 2015).

Cover Type	Mosher Slough	Delta Front[1]	Calaveras	SDC[3]	Mormon Channel	San Joaquin River Downstream of FCS[2]	French Camp Slough & Duck Creek	San Joaquin River along RD 17	TOTAL
WATERSIDE SLOPE									
Woody Riparian	3	2	7	0	0	5	13	16	**46**
Wetlands	0	0	1	0	0	0	0	0	**1**
Irrigated Grass/ Park	0	0	3	0	0	0	0	0	**3**
WATERSIDE EASEMENT									
SRA	6790	5,522	10,572	0	0	7,949	6,673	23,938	61,444
Woody Riparian	1	1	5	0	0	5	10	17	39
Wetlands	3	4	1	0	0	0	1	6	15
Irrigated Grass/ Park	0	0	1	0	0	0	0	0	1
LANDSIDE SLOPE									
Woody Riparian	8	25	47	1	0	5	20	6	112
Irrigated Grass/ Park	0	2	3	0	0	0	0	0	5
LANDSIDE EASEMENT									
Woody Riparian	7	3	11	1	0	3	3	9	37
Wetlands	0	0	0	0	0	0	0	0	0
Irrigated Grass/ Park	0	1	2	0	0	1	0	0	4
Orchard/Vineyard	0	0	0	0	0	0	0	0	0

Cover Type	Mosher Slough	Delta Front[1]	Calaveras	SDC[3]	Mormon Channel	San Joaquin River Downstream of FCS[2]	French Camp Slough & Duck Creek	San Joaquin River along RD 17	TOTAL
Row/ Field Crops	0	0	0	0	0	0	0	**8**	**8**
LEVEE CROWN									
Developed	2	12	25	14	0	2	3	34	92
Woody Riparian	3	0	0	0	0	0	4	0	7
SEEPAGE BERM									
Woody Riparian	0	0	0	0	0	0	0	5	5
Wetlands	0	0	0	0	0	0	0	0	0
Orchard/Vineyard	0	0	0	0	0	0	0	86	86
Row/Field Crops	0	0	0	0	0	0	0	0	0
NEW LEVEE									
Woody Riparian	0	0	0	0	0	0	2	0	2
Upland Trees & Shrubs	0	0	0	0	0	0	0	0	0
Wetlands	0	0	0	0	0	0	2	0	2
Orchard/Vineyard	0	0	0	0	0	0	0	9	9
Row/ Field Crops	0	0	0	0	0	0	1	18	19
MORMON CHANNEL									
Woody Riparian	0	0	0	0	47	0	0	0	47
Wetlands	0	0	0	0	1	0	0	0	1
Orchard/Vineyard	0	0	0	0	7	0	0	0	7
Row/Field Crops	0	0	0	0	0	0	0	0	0
TOTALS									
SRA	**6,790**	**5,522**	**10,572**	**0**	**0**	**7,949**	**6,673**	**23,938**	**61.444**
Woody Riparian	**22**	**31**	**70**	**2**	**47**	**18**	**52**	**53**	**295**

Cover Type	Mosher Slough	Delta Front[1]	Calaveras	Stockton Diverting Canal	Mormon Channel	San Joaquin River Downstream of FCS[2]	French Camp Slough & Duck Creek	SJR along RD 17	TOTAL
Upland Trees & Shrubs	0	0	0	0	0	0	0	0	0
Wetlands	3	4	2	0	1	0	3	6	19
Irrigated Grass/ Park/Golf Course	0	3	9	0	0	1	0	0	13
Orchard/Vineyard	0	0	0	0	7	0	0	95	102
Row/ Field Crops	0	0	0	0	0	0	1	18	19

[1] Delta Front = Fourteenmile Slough, Tenmile Slough, Fivemile Slough; [2] Includes Smith Canal Closure Structure; [3] Stockton Diverting Canal

Table 3. Vegetation and Land Type Effects by Alternatives (updated information provided by the Corps on June 15, 2016). Values are in acres except for SRA, which is lineal ft.

Land Cover types	**Alt 7a**	**Alt 7b**	**Alt 8a**	**Alt 8b**	**Alt9a**	**Alt 9b**
Natural Lands						
SRA*	19,630	49,586	25,674	51,985	25,508	51,819
SRA (Corps 2015a)	37,820	59,898	37,986	64,297	37,820	64,131
Riparian Trees and Shrubs	139	274	160	245	152	237
Agricultural Lands						
Orchards/Vineyards	0	95	0	95	4	99
Row/Field Crops**	15	32	15	32	16	33
Developed/Disturbed Areas						
Irrigated Grass	10	10	10	10	10	10
Ruderal	Not Estimated					
Paved/Graveled/Scraped						

* - Based on June 15, 2016 Corps email; SRA values are lower than in Corps (2015a) because they do not include ~12,000 lineal ft of SRA affected in Mosher Slough and portions of the delta front not considered in the NMFS biological opinion. The variation in this difference (10,000-18,000 ft) is not explained.
**Row/Field Crop effect values are 15 acres greater than in Corps (2015a) so as to include a setback area redesign which occurred after publication.

Even when this type of information is available, habitat in urbanized areas such as in the project area is not well-suited for analysis by traditional Habitat Evaluation Procedures models which are aimed at natural habitats in larger contiguous units. In the project area, vegetation is a mix of young volunteer growth on the water side, individual trees within the levee profile which are "protected" from immediate loss by State regulation of levee maintenance, and urban plantings on the land side. Urban terrestrial habitats are often considered lower quality than natural habitats because of limitations on size from maintenance, lack of multiple canopy layers, non-native species composition, smaller unit size, and disturbance from urban activities. Urban aquatic habitats are also viewed as secondary because of water and sediment chemical factors, bank hardening, dock structures, dredging, and association of non-native fish predators to this type of environment. Nevertheless, these urban habitats can provide important values on a regional scale because they represent the only remaining habitat remaining. If there is loss or further reduction in quality of this habitat without on- or at least near-site replacement, it can create a habitat void in the landscape.

Despite the limited quantitative analysis, the general effects of the preferred alternative can be summarized as follows. For the proposed project, permanent riparian losses are expected primarily along the margins of French Camp and Mosher Sloughs and Calaveras River due to construction as well as to establish and maintain compliance with the ETL. At best, a variance may permit a thin margin of managed vegetation to remain. A larger amount of urban trees land side but near to these waterways would also be lost. Some scrub and trees would also be removed for the delta front work. The gate closure structures would not directly affect much habitat, but will result in increasing effects on tidal function with sea level rise.

Once built, the levees must be maintained in accordance with Corps standards, with whatever variance is permitted. Detailed analyses during the PED phase may not result in an approved variance that is consistent with the assumption made during formal consultation for all reaches. Factors affecting the Corps' decision may include more detailed information on the composition, slope angle, extent of irregularities and undercuts, and other suspected factors that are not fully known at this time. The variance process will likely provide opportunity to improve some aspects of habitat quality, such as by removing non-natives in favor of natives. If an ETL variance is approved per the Corps' assumption in our Biological Opinion, a significant portion of the SRA impact could be avoided, or at least, have an allowance for some vegetation at the land-water interface. Benefits provided by this SRA, even in a limited form, include overhead and in-water cover, inputs of organic matter and insect drop, and forage and nesting habitat for birds and mammals. The assumption of an ETL variance, even if granted, would not allow the same kinds or densities of vegetation as is currently present. Limitations on woody vegetation size and type, and other maintenance requirements for maintaining visual sight lines and limiting animal burrowing are anticipated as part of that variance. Therefore, in addition to the 75-87% reduction in area which would allow woody vegetation, the quality of that remaining vegetation will be significantly reduced compared to existing conditions. Nevertheless, vegetation allowed under a variance would be far more desireable than full ETL compliance - which would create substantial corridor gaps and limit margin habitat to maintained annual grassland.

Although mitigation for the project as proposed must at least include that which is required by the formal consultation, those requirements only offset effects to listed species. Our Biological Opinion makes a finding, based on the Corps' project description including conservation measures, and other required Terms and Conditions, that the project does not jeopardize the existence or recovery of those listed species under our authority. The Biological Opinion does not address effects to other resources not involving a listed species. This detailed report represents the Service's recommendations for all resource effects of the project, and makes recommendations for the Corps to consider that we believe would best avoid and minimize effects. Included in these recommendations are possible changes to the project or form of mitigation. These do not change the finding or requirements in our Biological Opinion. If the Corps adopts any of these recommendations, reinitiation of formal consultation may be required.

In order of decreasing preference, the Service's preference for type and location of mitigation action for this project would be: (1) avoidance of impact, such as through changes in design or design approach; (2) minimization of impact, by similar means; (3) compensation on-site, as in the same location of the impact; (4) compensation near-site, and in-kind, as in very close proximity to the impact site on the same waterway, and of the same or similar habitat type, or, if an alternative habitat type - one which will benefit the affected fish and wildlife resources; (5) off-site compensation, also in-kind; and (6) off-site compensation, out-of-kind, meaning a moderately or completely different habitat type, but preferably, a cover type which is as or more desireable than that being affected. Existing conservation banks, due to their siting and other factors, would be considered of relatively low priority in this scheme.

Consistent with this hierarchy, we first recommend the effects of tidal gates be avoided by deleting the tidal gates and instead improving the slough levees up tide of the proposed gates (i.e., with levee raises and cutoff walls, as needed). We consider elimination of the tidal gate on

Fourteenmile Slough to be a much higher priority than the one proposed on Smith Canal. Fourteenmile Slough is a significant waterway in terms of length, size, and included tidal habitat which, like the lower portion of French Camp Slough, has been partially preserved over the last 100 or so years. The proposed gates and operation will have an increasingly restrictive effect on tidal flows and ecological functioning as sea level rises. The slough is largely surrounded by levees on both sides. Deficiencies and resultant needs to bring these slough levees up to the project design standards (200 year event + sea level rise) probably relate to levee height, seepage as a consequence of the materials in the existing levees, as well as numerous encroachments in the forms of boat docks, other structures, and individual trees. These encroachments would need to be removed, and much of the slough levees would need to be raised and have cutoff walls installed. More work would be needed on the right bank, because part of the left bank is already included in the delta front element. In order to maximally preserve tidal habitat, any additional land needed for these improvements would need to come from the land side of the levees. This would overlap back yards of residential properties immediately adjacent to the levees and possibly homes as well, requiring some relocations and other infrastructural work.

Smith Canal is of lessor priority as it connects to deep water in a more highly modified section of the mainstem San Joaquin River. Its location and straight alignment suggest it may be an artificial channel. A variety of fish have been collected in the State's beach seining program, which has a station at Dad's Point near the mouth of Smith Canal, including delta smelt and chinook salmon, so there seems to be at least some incidental use of the canal in some years.

The Corps should weigh the risks of retaining these gates in its design versus eliminating them in light of the uncertainties regarding the status and distribution of delta smelt and its habitat in the future. Delta smelt are currently infrequently seen in the project area, but this circumstance may change with sea level rise and changes to the water export system; this may cause salinity to intrude further, pushing the entrapment zone inland, including to the east towards the project area. Habitat restorations might be done in closer proximity to the project area which could affect the species distribution. Delta smelt populations, while currently very low, might increase. One study published since the Corps DEIS/R concludes that the Antarctic ice sheet may add more than a meter of sea level rise by the year 2100 (DeConto and Pollard 2016) which, if realized, would require even longer and more frequent gate operations than modeled by the Corps. These and other factors may further affect the abundance and distribution of delta smelt and, as a consequence, take of the species by this project. Our biological opinion establishes a fixed low threshold of take for reinitiation of consultation (i.e., two (2) larval or adult delta smelt east of the gate structures throughout the project life). While the need and outcome of such reinitiation in the future is uncertain, this can be avoided entirely by substituting the gate structures with slough levee improvements.

We also recommend the Corps consider near site locations in the French Camp Slough vicinity for habitat mitigation. One of these is an undeveloped area between Walther Slough and French Camp Slough just west of I-5. In 1913 topographic maps, this appears as open water or marsh (Figure 2). It apparently has since been used as a landfill, is higher ground, and is now capped. This past use and position within a floodway may explain the lack of urban development of this area. One mitigation concept would be to remove the landfill materials and restore tidal marsh and open water values, replacing functions and values of the types affected by gate closure operation. Another idea would be to repurpose Van Buskirk golf course, which borders the left bank of French Camp Slough and the San Joaquin River, into natural habitats. Here, a setback levee could be constructed which could support riparian forest and other habitat types.

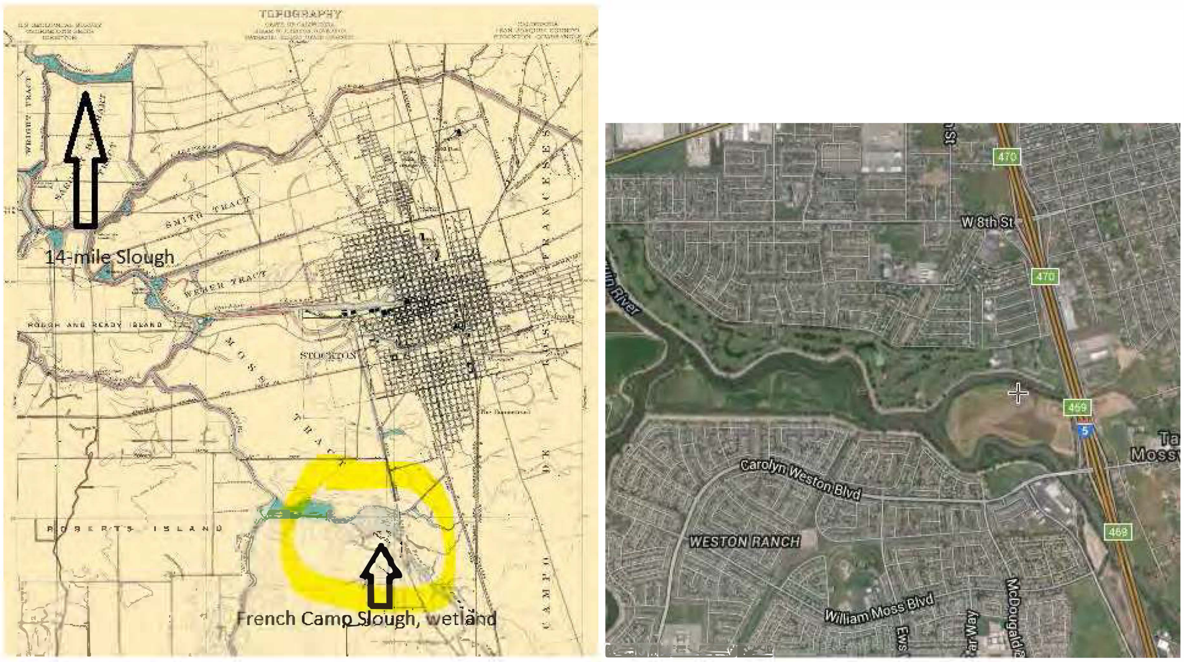


Figure 2. Location of potential mitigation site for tidal wetland and other cover types between Walther and French Camp Sloughs shown as a historic wetland in 1913USGS map (left, highlighted area) and current closed landfill in 2015 (right, near I-5). Van Buskirk golf course is to the left (east) of the closed landfill and is identified as a potential mitigation site for SRA and riparian cover.

The Corps should consider commissioning a custom mitigation option that provides tidal wetland/channel and SRA values much closer to the project area. Candidate areas for tidal restoration would be the low-lying, predominantly agricultural lands adjacent to major waterways and sloughs, in closest proximity to the areas being affected, in this case, Shima, Wright, and/or Rindge Tracts. These are also the areas which were the most recently reclaimed, appearing as tidal marsh around the turn of the century (Figure 3).

Approved conservation banks are an acceptable form of mitigation for the proposed project, although the least preferred option in this case. The Liberty Island and North Delta Conservation Banks are shallow tidal wetlands which provide values to the delta smelt. The Cosumnes Floodplain Mitigation Bank has SRA, floodplain wetland, and floodplain riparian habitat credits which would provide values to listed salmonids. The service area of these banks includes the proposed project area, but they are all at least 20 miles from the project area, and would be considered off-site. There are also differences in the nature of the project effects and the benefit of such bank credits. The project effects include both local losses of access to habitat, as well as functions as a result of tidal exchange. These will not be replaced on site. The distribution of

Figure 3. Upper: 1895 San Joaquin county map depicting the extent of marsh (shaded area) on Shima, Wright, and Rindge Tracts in proximity to Fourteenmile Slough (arrow); Lower: 2015 satellite image of same, showing urban expansion, and the rerouting and widening of some channels in the vicinity.

this habitat over the landscape can be a factor in determining the benefit to a species. For example, delta smelt may migrate to different parts of the Delta, depending on water year, flow, and other factors. Juvenile salmonids may use a series of locations to rear and grow. An accumulation of impacts in some portions of the Delta that are mitigated elsewhere can, over the long term, affect the range of a species or local subpopulations.

There is a ~0.5 mile long section located on the left bank of the Calaveras River where the levee is set back away from the water's edge (Figure 4). It appears to be higher ground which may be partially fill. A portion of the section appears to be a covered dock or marina. This site should be considered as potential on- or near-site mitigation to offset SRA and riparian value losses.

Figure 4. Location of existing set back area of levee on the right (south) bank of the Calaveras River recommended for consideration as SRA and riparian cover mitigation. Red shading is the extent of the existing levee profile plus maintenance easements.

As a possible option to the setback area along Fourteenmile Slough, there is considerable opportunity to increase SRA and riparian cover along RD 17 phase III if a modified design were developed there and then added to the preferred alternative. Rather than the fix-in-place approach with cutoff walls, seepage berms, and limited setbacks currently proposed as a Section 408 project, it could be done with a larger setback(s) that would allow significantly more SRA and riparian cover types. The Corps' version for RD 17 (Alternative RD 17-E *in* Corps 2015a), which was not included in the preferred alternative, had one significant setback area, <1 mile long out of the ~9+ mile east bank length, in the vicinity of Old River. However, the Corps previously conceived a much larger setback in the northern portion of RD 17 (Alternative RD 17-G *in* Corps 2015a) that would yield 4-5 miles of such SRA, but did not carry it forward because it had lower net economic benefits. The State has included a concept similar to

Alternative RD 17-G in the tentatively recommended plan for its San Joaquin Basin Wide Feasibility Study (BWFS) (Figure 5). The BWFS identifies those components which the State would recommend be included in the preferred alternative in future State-Federal feasibility studies. This modified option for RD 17 would induce significant development of much of RD 17, but less than that which is currently proposed as a Section 408 project, while providing for habitat enhancement and buffer distance between urban development and the river.

Neither the tentatively selected plan, nor any of the alternatives, appears to address the original planning objective of ecosystem enhancement or restoration, which would be beyond that required for mitigation of impacts. Examples of enhancement opportunities already identified in the BWFS include levee setbacks that would allow more habitat (RD 17, River Miles 60-65 on the mainstem San Joaquin River, Paradise Cut, Mormon Slough; Figure 5), protection to ensure the future of existing habitat (e.g., through the creation of conservation easements), or additional measures to facilitate restoration on otherwise protected lands, consistent with any flood control purpose (plantings, earthwork, habitat structure). We recommend the Corps review these opportunities, and include ecosystem restoration and enhancement elements in its preferred alternative that would achieve this planning objective.

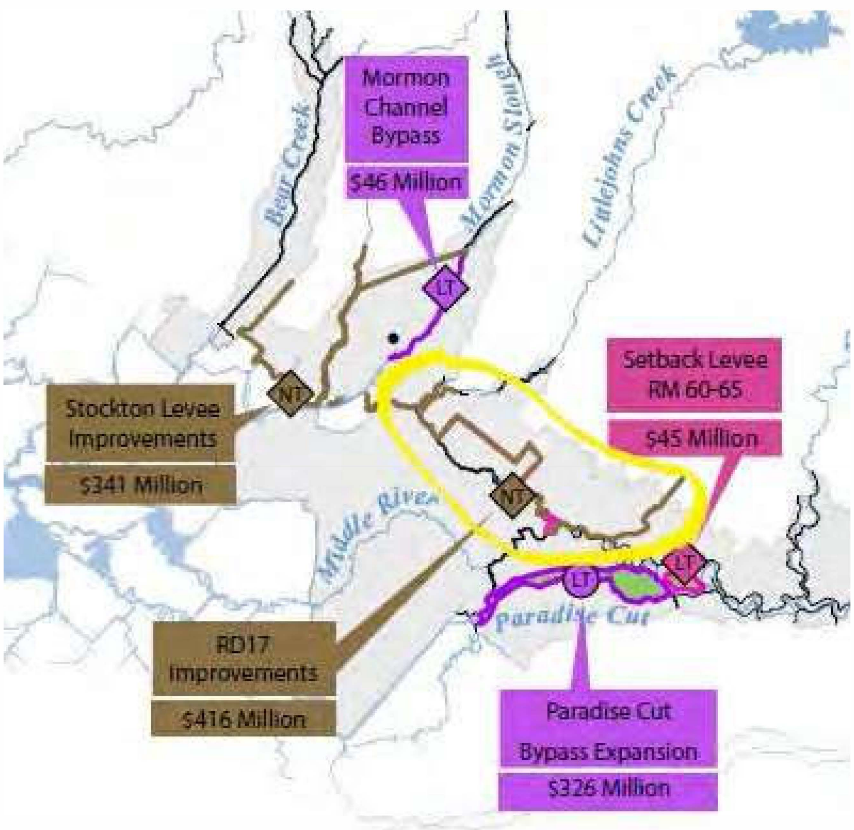


Figure 5. Elements of the State's Basin-Wide Feasibility Study tentative recommended plan in the vicinity of the proposed project include several regional options for habitat enhancement. Improvement to RD 17 with an additional setback area downstream of Middle River in lieu of fix-in-place improvement is highlighted (alignment offset within yellow circle).

CONCLUSION

For the San Joaquin River Feasibility Study, our findings are limited by the comparatively low level of quantification for a Federal project of this scope. Based on the available information, we conclude that the preferred alternative will result in reductions in the amount and value of riparian and SRA cover on several urbanized waterways in the greater Stockton area that will require mitigation. Due to the local rarity of this remaining habitat, and uncertain future consequences of sea level rise and urban development, we recommend project modification in the form of deleting at least one tidal gate, the one on Fourteenmile Slough, and instead raising the slough levees. We also prefer mitigation be done nearer to the project area than existing conservation banks.

RECOMMENDATIONS

For the proposed Lower San Joaquin River Feasibility Study, the Service recommends the Corps:

1. Resolve uncertainties and information gaps in the study, as follows:

   a) Determine vegetation impacts and future allowances in all project locations with certainty, prior to construction;
   b) Comprehensively evaluate the effects of tidal gate operation on salinity, flow, temperature, other water quality factors, and all relevant ecological processes and related recreational activities, in the affected sloughs and adjacent waterways; this should include analysis for reasonable sea level rise predictions over the project life.
   c) Conduct ground-based assessment of vegetation losses, including but not limited to cover typing, species, height, diameter, substrate, and inundation frequency; and a habitat evaluation procedures study if deemed appropriate by the Service;
   d) Develop and propose mitigation to offset habitat losses, using the guidance provided in this report (see Discussion, above), with exact locations and quantities of all mitigation plantings, and plans for monitoring;
   e) Complete a quantitative assessment of impacts for the preferred alternative; and
   f) Identify staging and borrow areas.

2. Evaluate and consider the following alternative measures to avoid impacts, and locate mitigation sites as near to the impact sites as possible before going off-site to approved conservation banks:

   a) Eliminate the proposed tidal gates, especially the one on Fourteenmile Slough, and instead improve the slough levees, as a means to avoid impacts of gate operation to tidal habitat and function;
   b) Restore the historic wetland between Walther and French Camp Sloughs, including removal of capped landfill material;
   c) Create tidal wetlands as near as possible to impact sites on Shima, Wright, and/or Rindge Tract lands;

d) Create SRA and riparian cover as near as possible to impact sites on candidate areas identified on French Camp Slough north bank (Van Buskirk golf course) and the lower Calaveras River south Bank (existing set back levee area);
e) Develop an alternative for RD 17 phase III improvements that combines a setback levee with restoration of SRA cover to the maximum extent possible.

3. Develop an operations and maintenance manual for completed project features to provide maximal habitat value conditions consistent with any approved ETL variance, other maintenance standards needed for project reliability and safety, and the Service's and NMFS' Biological Opinions. This may include measures such as selective removal of non-natives and planting of natives

4. Reinitiate section 7 consultation with the Service and NMFS as appropriate for any changes in the project description, including but not limited to development of a mitigation plan;

5. Conduct appropriate consultation with the CDFW on effects to State-listed species;

6. Develop enhancement and restoration opportunities for incorporation to the maximum extent possible into the preferred alternative for the project.

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In Reply Refer to:
2022-0043398

Ms. Alicia Kirchner
Chief, Planning Division
Sacramento District
U. S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Subject: Supplemental Fish and Wildlife Coordination Act Report for the Lower San Joaquin River Feasibility Study - Segment TS_30_L Habitat Evaluation Procedures

Dear Ms. Kirchner:

Per our Scope of Work for FY 2022, please find enclosed the subject report.

If you have any questions, please contact Steven Schoenberg of my staff at (916) 930-5672, or by email at Steven_Schoenberg@fws.gov.

Sincerely,

Daniel Welsh
Deputy Field Supervisor

Enclosure

cc:
Dave Fluetsch, Corps of Engineers, Sacramento, CA
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SUPPLEMENTAL FISH AND WILDLIFE COORDINATION ACT REPORT FOR THE LOWER SAN JOAQUIN RIVER FEASIBILITY STUDY: SEGMENT TS_30_L HABITAT EVALUATION PROCEDURES

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INTRODUCTION

This report is a supplement to the Fish and Wildlife Service's (Service) Fish and Wildlife Coordination Act (FWCA) detailed report (hereafter, "2016 FWCA") on the U.S. Army Corps of Engineers (Corps) Lower San Joaquin River Feasibility Study (LSJRFS) (FWS 2016). The purpose of this supplemental report is to present the results of a habitat evaluation of one reach segment within that study known as TS_30_L. We also provide preliminary recommendations for the siting of mitigation for the impacts of construction of that reach.

BACKGROUND AND COORDINATION HISTORY

The preferred alternative for the proposed project (alternative 7a) involves some 24 miles of levee improvements, of which TS_30_L is part, and two tidal gates in an overall effort to protect greater Stockton from flood events. The 2016 FWCA did not include a formal habitat evaluation of any of the project elements because of limited information, and funding and schedule constraints within the Corps' "SMART" planning guidance (Corps 2015a). Therefore, we were limited to a Corps-provided desktop analysis using aerial images and their estimates of impact, and our own observations during several hours of site visits to the project element locations. The 2015 draft Integrated Feasibility Report/Final Environmental Impact Statement/Report (FS/FEIS/R) stated that a full mitigation plan, including field surveys and habitat evaluations as appropriate, would be done during the Pre-construction Engineering and Design (PED) phase (Corps 2015b).

The Corps issued a final FS/FEIS/R for the project in 2018 (Corps 2018). There are significant differences from the project as described in the final environmental document (Corps 2018). The 2018 FS/FEIS/R states that mitigation bank credits would be obtained to offset impacts of the project; however, such credits are not currently nor foreseeably available. In response to our 2016 FWCA, the Corps also committed in its 2018 FS/FEIS/R to evaluate other on and near impact site opportunities for mitigation, including some we had identified (FWS 2016). The project elements that would incorporate mitigation for impacts included one setback levee, within Fourteenmile Slough, which would incorporate mitigation in the forms of some riparian and Shaded Riverine Aquatic (SRA, a type of riparian cover adjacent to water) cover types, and was also intended to accept elderberry transplants (host plant for the federally listed Valley Elderberry Longhorn Beetle, or VELB) from other parts of the project. However, constructing other reaches like TS_30_L in advance of the Fourteenmile Slough element creates the additional need to develop mitigation elsewhere.

The Feasibility Study entered the PED phase around October 2019 and the Service was funded in late 2020 to resume FWCA coordination activities. The Corps had selected the segment TS_30_L as the first construction element, a 5,900 foot long stretch of levee bordered at the south by March Lane and to the north by the Fourteenmile Slough levee near White Slough. In environmental documents and our 2016 FWCA report, this segment is one of several in the Delta Front work element, which includes Shima Tract, Fivemile, Tenmile, and Fourteenmile Slough, with "TS" referring to the Tenmile Slough levee. The work at TS_30_L originally involved the installation of cutoff walls, slope reshaping, and application of west facing rock protection.

Project refinements to TS_30_L have since been identified which would likely increase impact beyond the estimates in the environmental documents, including a 20-foot westward levee prism shift which is needed to allow room for a patrol road to inspect the land (east) side of the levee. This would extend water side work (rock revetment, patrol road, levee reconstruction), in most sections, all the way to the irrigation ditch (the westward extent of the natural habitat). Additionally, at the time of the 2018 FS/FEIS/R, there was consideration of applying for a variance which would permit some vegetation on the lower slopes of levees. During PED, however, the Corps determined it would not seek a vegetation variance, but might consider a design deviation based on risk assessment which could permit some vegetation growth. Whether or not a design deviation is approved, nearly all vegetation within the impact footprint area would be removed initially due to earthwork.

A more detailed site visit to the TS_30_L impact area was conducted in March 2021. Among the more notable observations was the apparent high wildlife use by songbirds and raptors, elderberry bushes, and mixture of habitat elements (trees, snags, shrubs, herbaceous areas, native trees, exotics). Persistence of the habitat appeared to be a consequence of both proximity to an irrigation drainage ditch, and apparent low maintenance at least on the lower levee slope. Several potential areas for mitigation were discussed and/or looked at briefly in early 2021 as well.

We provided a site visit report in March 2021 with our findings and, after further review of the project history, we also provided a May 2021 guidance memo with our preliminary recommendations for mitigation and imminent construction as it pertains to TS_30_L. In brief, we concluded no path forward to 2021 construction because of unresolved matters of project impacts without mitigation agreed and in place prior to project impacts, unevaluated changes to the project, elderberry impacts which required reconsultation, and the need to evaluate on/near site mitigation options. Our primary recommendation, if the Corps intended to proceed with TS_30_L construction in the near term, was to plan a mitigation area in a corridor adjacent to the affected habitat.

Beginning late August 2021, the Service participated in a number of calls with the Corps related to the sequencing of the project, various mitigation locations and ratios, and technical assistance under the Endangered Species Act (ESA) regarding federally listed species. The Corps planned to proceed with the project beginning with vegetation removal in early 2022 in advance of other construction. To quantify the baseline habitat value of the impacted areas before these anticipated impacts, the Corps communicated to the Service the need to conduct a habitat evaluation of the impact area of TS_30_L. That habitat evaluation, based on field work conducted in December 2021, is the focus of this supplemental report. At the time of the writing of this report, vegetation has not been impacted because the project has not yet begun. On July 26, 2022, the Service attended a site visit to view additional potential mitigation sites. To better assist the Corps' mitigation planning, this report also includes an initial evaluation and prioritization of these mitigation sites based on our observations and best professional opinion.

HABITAT EVALUATION PROCEDURES

Habitat Evaluation Procedures, or "HEP", is an accounting methodology developed by the Service and other agencies to quantify habitat value of a particular area of habitat to selected wildlife species or communities associated with that habitat (FWS 1980a, 1980b, 1981). It is based on models which calculate an index value between 0.0 and 1.0, the Habitat Suitability Index (HSI), that is used to weight habitat area. HSI models consist of a set of habitat variables which are measured or estimated (usually denoted V1, V2... etc.) that are considered important life requisites to the particular wildlife species or community. These variables, or Vs, are converted to Suitability Indices (SIs) using graphical relationships or best-fit word descriptions provided in the model that assign an index value to a measured or assumed variable quantity. The SIs are then combined using equations to obtain the HSI. A series of HSIs are estimated for several points in time in the future (called Target Years, or TYs), over the life of the project; these sets of HSIs for the target years are commonly referred to as "futures". For these futures, the HSI is multiplied by the habitat area to obtain habitat units, which are summed and averaged over the life of the project (Average Annualized Habitat Units, or AAHUs). This routine can be applied to both an impacted project site and a proposed mitigation site. AAHUs are used as the metric to compare habitat values of the future without the project to the future with the project.

APPLICATION AND LIMITATIONS

HEP is a tool that can be useful in assessing the need and adequacy of mitigation for impacts of an action but it has limits and assumptions. AAHUs for a mitigation site can be compared to that of an impact site to estimate the area of mitigation necessary to provide at least the same habitat value. HEP does not normally include and therefore does not evaluate habitat values within a landscape context: corridor values that permit the movement of wildlife across a landscape, the distribution and rarity of habitat across a region, actual use by wildlife, or the interaction between habitats, agriculture or urban components. It is often a coarse evaluation, subject to error in the measurements themselves and variation in the way wildlife resources use habitat in different regions of the Country. HEP is also not used for listed species. Instead, mitigation for effects on listed species is determined separately during ESA consultation, often using guidance documents and similar treatment as in other consultations for the individual species. Listed species guidance can vary, and may involve the use of standardized mitigation ratios and other factors.

MODEL SELECTION

The process of model selection for this HEP study involved preliminary assessment of the habitat during a site visit, a review of available models, and communication with a HEP team that included Service and Corps staff. Models were selected that we considered to best represent the values of the affected habitat and mitigation, and the majority of the habitat components. A site visit was first conducted on March 9, 2021. Vegetation had just started to leaf out, however, the general habitat characteristics could be observed. There was a mix of woody vegetation dominated by dense shrub species, particularly willows, blackberry, and buttonbush, together with some larger and taller willows, other taller trees such as oaks and some non-natives (walnuts, pecan) and patches of rose and elderberry. Snags (larger dead limbs or entire dead trees) were evident throughout the site. The woody vegetation was interspersed with tall herbaceous plants, especially thistle. Wetland patches were also seen in association with what appeared to be an agricultural drainage ditch at or slightly beyond the toe of slope, which was maintained on the west side and had water (or evidence of recent water). At this time, and in subsequent visits to the site, a variety of avian wildlife were noted such as hummingbirds, sparrows, mockingbirds, raptors, quail, and others. The habitat mix varied over the length of TS_30_L, with areas dominated by shrubs, trees, or herbaceous plants, depending on exact location.

On the basis of these initial observations, we reviewed available models and selected a suite of five HEP models that would complement one another and best represent the values provided by the existing habitat. These included published models, modifications to published models, and in-house unpublished models locally developed and applied to evaluations of other Corps projects. A HEP "package", consisting of the models, summary of methods, and basic rationale, was provided to the Corps prior to field sampling. The Corps noted prior to field sampling, per their current guidance, that unpublished and modified models would need to undergo a certification process, which involves review by the Corps' Engineering Research and Development Center (ERDC) and communication with Service staff. However, given the field conditions (late fall), the Service and Corps mutually agreed to proceed and complete field sampling, in advance of completion of the certification process. The Service responded to all ERDC requests for documentation and justification of models used to the extent these were available. The Corps notified the Service that certification was forthcoming, and to proceed at least for use in this specific application (HEP evaluation of TS_30_L) (August 4, 2022, email from David Fluetsch, Sacramento District). The selected models and rationales are as follows:

Yellow Warbler (Schroeder 1982): The preferred habitat of this species is a deciduous riparian assemblage of hydrophytic species such as willows and cottonwoods. It is a summer resident in similar habitat in the Central Valley of California. This model emphasizes the lower and middle canopy and the habitat preference of this species for hydrophytic shrubs. The Service developed and validated this model for use throughout this species' range; however, the original model is derived from early work in the eastern United States which acknowledged forest use as occasional only. That original model had three variables, all associated with shrubs and/or lower canopy (percent deciduous crown cover, average shrub height, and percent hydrophytic shrubs). We used a modification of this published model that we had also applied to other local Corps Federal projects since 1998. This modification added a fourth variable for tall trees, consistent with forage beats by this species in the West ranging up to 40 feet above the ground, presence of trees in portions of the project area, and expected effect of the project on this combination of tall trees with a shrub understory. During the Corps' certification process, we researched and responded to Corps questions to justify this modification, noting that partial use of the higher canopy by this species had been well documented in the West.

Riparian Songbird Guild (Roberts et al. 1986): This is an unpublished model originally developed for application to forested or scrub-shrub wetlands in Humboldt Bay, and was the original model used to evaluate riparian forest habitat in the 1999 and 2009 HEPs of the Corps' Napa Creek project (FWS 2009). It is intended to apply to a relatively broad range of bird species (mostly in the order Passeriformes, but also associated species in the order Piciformes) that use plants, snags or associated insects for food, or use the plants and snags for nesting. Variables include shrub and tree cover, tree height, canopy layering category, snags, and overall woody cover. The variables focus on somewhat shorter canopy elements. This model has the smallest snag dimension (4 inches) of the three models with snag variables used for TS_30_L. This was deemed appropriate because of the presence of woodpeckers and birds at TS_30_L, and the small snags present that would be impacted by the project.

Riparian Forest Cover Type (DeHaven 2001): This unpublished model was developed by the Service's Sacramento Fish and Wildlife Office originally for Corps bank protection actions along the lower Sacramento River, and was later modified for use in the Corps' Llagas Creek project. It is a generalist model, intended to quantify values to a range of bird and mammals that could utilize this habitat. It combines vegetation parameters such as height, closure, stand width, understory, and species number, and has discounting factors for non-native dominance and distance from water. This model is sensitive to structural diversity of habitats and narrowing of corridors by project actions. It was considered appropriate for TS_30_L in light of the combination and variation in tree and shrub cover, and stand width, at this location.

Downy Woodpecker (Schroeder 1983): The species' habitat covered by this published model associates primarily with older soft wood riparian species like willow and cottonwood in lowland stream bottoms. Older trees are not common in TS_30_L, but are present and considered a significant component which would be affected by the project. The variables are snags (6 inch minimum; required for value) and basal area at breast height, the latter of which can only be coarsely estimated in thick young stands such as TS_30_L. Nevertheless, this model was included in this HEP analysis because it reflected the values, albeit limited, of this older vegetation component, the presence of snags at TS_30_L, and the observation of cavity dwellers such as woodpeckers and owls at this site.

Hairy Woodpecker (Souza 1987): The habitat represented by this published model is also older, larger, trees in a variety of forest types and densities. Measurements include mean tree diameter at breast height (used in two suitability indices), canopy cover, and snag count. It has an even larger snag dimension criterion (10 inches) than other models in this HEP study. It was included for the HEP at TS_30_L as an alternative to the Downy Woodpecker model. This model emphasizes larger trees and snags, but without an absolute requirement for snags to yield value in a plot. Larger trees and snags were present, but infrequent and patchy, at this location.

STUDY ACTIVITIES

The HEP evaluation for TS_30_L involved the following sequence of activities:

a) *Field Sampling*: Sampling was conducted on December 2, 3, 7, and 8, 2021. The Service author of this report was present on all days (Steven Schoenberg, Senior Biologist), and was assisted by one or two Corps staff each day (Savannah Fahning, Jessica Agajan, Steve McLemore, Miranda Doutch, or Dave Fluetsch). Conditions were considered fair due to some leaf drop and shedding of terminal branches, but acceptable for the purposes of the study. The suboptimal field conditions mean that there is some potential underestimate of features such as woody vegetation height and cover that could result in an underestimate of baseline value, but not to a major degree. The measurement requirements for the selected models included both transect and plot based parameters.

The plot size and extent of effort for each parameter was tailored by the Service staff's best judgement to complete the sampling in a reasonable time, given the size of the site, the need to assess 20 variables in the five models, limited remaining season due to ongoing leaf and branch shedding, and short days at the time of the field work. The TS_30_L site is also typified by the presence of a dense, often thorned, lower shrub layer, and patchy dense woody stems. The limited time available to meet these study needs and difficulty moving within a site with these characteristics necessitated a coarse, visual estimation of some variables. Detailed measurement protocols for each variable are provided in Appendix A, TAB: Models.

Taking these factors into consideration, a plot length of 300 feet was selected, which could be sampled within study time constraints while still capturing the variation in habitat suitability over the length of the site. Two perpendicular transects were set up in each plot. Transect position within a plot was decided by selecting two single digits from a random number table (1-9), which were each multiplied by a tenth of the total plot length to determine the locations of the perpendicular transects. After a plot and its transects were set up, a waypoint location of the beginning (south end) of each plot was recorded on a GPS device. When all sampling was completed, the spatial data for the plot boundaries were downloaded from the GPS device using the software Garmin Basecamp, and converted to a shapefile (Appendix D, Plate 1). Three photographs were taken on each plot, one facing north from the beginning of each plot, and west across each of the two perpendicular transects. Measurements were recorded on paper data sheets, one per plot (Appendix C). All raw data were entered into a multitab Excel spreadsheet file, designed to convert the data into SIs and HSIs for each model (Appendix A). In a few rare instances of missing data, all noted in Appendix C, either reference photos and/or similar data from other models were used to develop a best estimate of values for those variables.

b) *Data Reduction*: Measurements from the two transects for each plot were averaged to obtain plot specific values for the transect-based measurements and, with the values for the other full plot measurements, were used to obtain a single plot-specific variable for each SI and then, using the model equations, plot specific HSIs for each model. These plot-specific HSIs were averaged to determine a reach-wide HSI for each model. This manner of calculation, with plot-specific HSIs used to obtain a reach-wide average, is typical in HEP studies. Some test calculations were done by assigning a single, reach-wide average SI for snag density and basal area to each of the plots, to see if variation between plots in these particular variables might bias the reach-wide HSI. However, these test calculations showed that the reach-wide average HSI would be the same with either calculation routine (Appendix A, TAB: HSIdatacalcs, lines: 224-225, 282), so this alternative routine was not used, and is not discussed further in this report.

c) *Futures*: Initial, solely HEP-based, estimates of mitigation needs were made by developing mitigation site futures and calculating and comparing changes in habitat value (AAHUs) for the Corps-determined 13.88 acre impact footprint and a hypothetical 10 acre (ac) restoration site (Appendix A, TAB: futures). The ratio of losses at the impact site to gains at the restoration site, adjusted by area, is the theoretical mitigation ratio. As noted in the general assumptions described below, for the purposes of this exercise, we assume that restoration at the mitigation site, including planting, is complete by the time of first project impact.

Two future comparisons were done. In the first, we varied habitat development. Two future scenarios were developed to describe the range of potential mitigation ratios and areas: a "best case" scenario with the fastest development and higher optimum ranges reflective of high management and success; and a "worst case" scenario, which has a more moderate rate of habitat development and maxima. This "worst case" scenario is not unsuccessful, but takes into consideration the possibility of less than fully optimal habitat for certain model parameters. Such limits on habitat potential may reflect constraints created by variability in weather and water availability, unforeseen disturbances like fire and disease, site-specific limitations such as power line easements, natural variation in parameters, and/or reduced long term management.

In the second comparison, we varied mitigation start. We compared mitigation that was started 10 years prior to impact, with mitigation concurrent with impact, for the worst case scenario only (see RESULTS, below).

d) *Mitigation Site Qualitative Evaluation*: Based on site visit observations, and our best professional opinion, we analyzed six identified locations in terms of other habitat value characteristics not reflected in the selected HEP models (distance from impact, corridor value, utility easements, buffer value, adjacent land use, floodplain/connectivity to delta waters, benefits to special-status species, unit size, etc.). Together with the futures estimate of mitigation site habitat value from the HEP, this qualitative evaluation was used to prioritize the sites and propose a recommended mitigation ratio for each location.

c) *Documentation*: Documentation of study activities is provided within the Appendices of this report (Excel spreadsheet, data forms, models, plates) and/or, as appropriate, is maintained in electronic files at the Service's field office (Excel spreadsheet; shapefile of plot boundaries; reference photographs; email communications).

ASSUMPTIONS

The following assumptions apply to the analysis and findings in this report:

-The impact site at TS_30_L, about 13.88 ac, can be adequately assessed as a single cover-type consisting of a mosaic of patches of scrub, herbaceous, scrub and tree cover in varied proportions, wetland, and ditch cover.

-All vegetation will be initially removed within this 13.88 ac project footprint.

-For the purposes of assessing without-project habitat value, we assume that the baseline measurements in this HEP are representative of the future, which is explicit in the calculations as shown by a constant HSI for the life of the project, without the project.

-The life of project is 50 years, equivalent to the period of economic analysis, and the period of analysis is 51 years, equal to the life of project plus construction, assumed to be one year.

-There is an inherent, unknown, level of error due to simplification of the measurement techniques for many of the variables, such as rough visual estimates of cover proportions (see Appendix A for details). Nevertheless, the measurements are assumed to be of adequate accuracy to represent existing habitat values of the site and hence, determine the losses and mitigation need associated with project implementation.

-There is also an inherent, unknown, level of error due to simplification of the calculation procedure, which uses the average HSI across plots and the overall impact area (13.88 ac), to calculate habitat value. Again, although higher precision is possible with a stratified sample across patch subtypes, and much greater effort, the simplified procedure is assumed adequate to represent existing habitat values and losses with project implementation.

-For the purpose of the simplified analysis of futures, below, we assume that mitigation site construction is completed at Target Year 1, the time of impact. Impact in this situation is the clearing of vegetation in TS_30_L, which would occur in the winter preceding construction-related earth-moving later that same year. In habitat restoration, earthwork is done before planting. Accordingly, the results discussed below for concurrent mitigation would apply only to a situation where restoration is complete (i.e., including planting), by the time of first impact.

RESULTS

Results are expressed in habitat value changes, in AAHUs, calculated for the five models at the impact site and a theoretical 10 ac site under best and worse case future scenarios (Table 1).

Table 1: Habitat Values for TS_30_L HEP study. Impact is loss of December 2021 baseline. Mitigation is for a conceptual 10 ac site started concurrent with construction, under best and worst case future habitat scenarios. See text and Appendix A for details.

	Habitat Value change, AAHUs			area to offset AAHU loss, ac		"mitigation ratio"	
future habitat scenario:		best	worst	best	worst	best	worse
	Impact	mitigation	mitigation				
Model:	TS_30_L	10ac	10ac				
Yell. Warbler	-8.8	8.8	5.9	9.9	14.9	0.72	1.08
Rip. Songbird	-8.8	5.7	3.0	15.5	29.3	1.12	2.11
Rip. Forest CT	-10.0	8.9	5.4	11.3	18.8	0.81	1.35
Downy Wood.	-3.2	2.1	1.4	14.8	22.2	1.07	1.60
Hairy Wood.	-0.9	4.1	0.9	2.1	9.2	0.15	0.88

Comparison of the losses at the impact site to the gains at the theoretical mitigation site is used to determine the mitigation need in terms of acres and the mitigation ratio. In such an analysis, it is customary for the Service to apply to its recommendation the result from the model that shows the greatest ratio. This practice ensures that in-kind values for other models with lower ratios would be at least fully compensated. For TS_30_L under the stated assumptions, and assuming a reasonable worst-case future scenario for mitigation, full compensation for loss of habitat values for all models would be achieved by a ratio (impact site: mitigation site) of about 2.11:1. This would require a riparian mitigation area of 29.3 ac to offset the habitat value impacts to the 13.88 ac at TS_30_L. As we explain below (Analysis), this result is not a precise prescription for our mitigation recommendation due to factors beyond the scope of the models.

We also conducted a futures analysis to compare mitigation scenarios (worst case only) where the mitigation was assumed initiated 10 years before impact (Table 2). This was intended to illustrate the mitigation value in excess of that needed for TS_30_L, which could be used to offset a future impact (APPENDIX A, TAB: futureexcess). For purposes of this exercise, we assume that the impact is the same as TS_30_L, although another reach would likely have a different baseline and area. Over a 51 year period of analysis of that scenario, an earlier mitigation start lowered the mitigation ratio. The greatest difference is for the Hairy Woodpecker model (ratio of 0.49 compared to 0.88, above) which is attributed to the longer period of snag presence. The minimum effect, for the Riparian Songbird Guild model, is slight (ratio of 2.05 compared to 2.11, above). Taken together, the results indicate that the recommended mitigation ratio with advance mitigation (or remaining excess used for future impacts) remains about 2:1.

Table 2: Habitat Values for TS_30_L HEP study. Impact is loss of December 2021 baseline. Mitigation is for a conceptual 10 ac site started either concurrent with construction or 10 years before construction ("10 yr", below), under worst case futures scenario. See text and Appendix A for details.

	Habitat Value change, AAHUs			area to offset AAHU loss, ac		"mitigation ratio"	
start scenario:		concurrent	10 yr	concurrent	10 yr	concurrent	10 yr
site:	Impact	Mitigation	Mitigation				
Model:	TS_30_L	10ac	10ac				
Yell. Warbler	-8.8	5.9	6.7	14.9	13.1	1.08	0.94
Rip. Songbird	-8.8	3.0	3.1	29.3	28.4	2.11	2.05
Rip. Forest CT	-10.0	5.4	5.7	18.8	17.7	1.35	1.28
Downy Wood.	-3.2	1.4	1.5	22.2	20.8	1.60	1.50
Hairy Wood.	-0.9	0.9	1.3	9.2	6.8	0.88	0.49

ANALYSIS

Here, we consider differences between the impact site and alternative mitigation locations (Appendix D, Plates 2-3). This analysis involves other factors not inherent in HEP which, together with the HEP results, are used to develop recommendation for siting priority and site-specific mitigation ratios for impacts at TS_30_L. Unless noted otherwise, the sites are privately owned. These mitigation locations are:

- Adjacent Corridor: This would be immediately west of TS_30_L, about 80-100 feet wide and roughly the length of TS_30_L. This would make it about 25 ac, corresponding to the parcel in which it is located. There is a force sewer main and associated easement running the full north-south length of the parcel and another shorter easement where high power lines cross. As with TS_30_L, adjacent land use is residential to the east and rice agriculture within this site and to the west.
- Manteca: This site is located 18 miles south of TS_30_L, about a half mile southwest of the intersection of South McKinley Street and Pink Muhly Lane. About 150 ac, it is currently in agriculture (gourd such as squash or pumpkin). It is surrounded by levees, and part of the site is close to Walthall Slough, a perennial waterway which has some natural oak woodland, riparian, and wetland vegetation.
- Van Buskirk Park: This site is about 5 miles south of TS_30_L along the right (north) bank of French Camp Slough. It is a recently decommissioned golf course with redevelopment pending, on land deeded to the City of Stockton for the purpose of community recreation. Currently, the site has been cleared of most woody vegetation, although some scrub has regrown in former water features. The mitigation concept is to include a component of habitat restoration of some of the 152 ac in redevelopment of the site in a way that would be consistent with that purpose. Improvement of the levee at this site is another component of the LSJRFS, although it could be set back or modified to provide tidal influence and additional benefit.
- Kumar Property: This site is a horseshoe-shaped area of 50 ac, currently with young olive trees, that surrounds another 40-50 ac mitigation site managed by the Center for Natural Lands Management known as the Pace Preserve. This mitigation site has a mosaic of trees, shrubs, and wetlands. High-power lines run through the site. It is several miles west of TS_30_L. The idea at this site would be to remove the olive trees and perform habitat restoration. Vegetation may be limited under the power lines.
- Solari Property: This 50 ac site is fallowed, former farmland with a few shrubs. It is also a few miles west of TS_30_L. It appears bordered by hay fields. It is perhaps 100 yards or so from the San Joaquin River, which is leveed. There are no visible power lines or other known utilities.
- Pump Station: This 113 ac site is a mile or so north of TS_30_L at the corner of 14 Mile and White Sloughs. An actual pump station takes up a small portion of the site, and another portion of the site was used at one time as sewage ponds. Several high-voltage lines and associated towers run through the site. Most of the site is fallow herbaceous weeds, and some scrub. The concept for this site would be to restore riparian (with shorter habitat types or wetland under power lines). It may be possible to modify the levee alignment to allow tidal exchange.

PRELIMINARY MITIGATION RECOMMENDATIONS

The recommendations in this report are to be considered preliminary due to the limited information about the mitigation sites. These recommendations are based on the Service's best professional opinion on resource considerations only, such as habitat quality, fish and wildlife resource needs - including those of listed species, and landscape factors. Other factors such as real estate acquisition, cost, and implementation schedule are beyond our purview and are not discussed. As originally described in our FWCA report for the LSJRFS, repeated below, we use similarity in location and habitat type to prioritize mitigation options (Service 2016, p. 28):

> "In order of decreasing preference, the Service's preference for type and location of mitigation action for this project would be: (1) avoidance of impact, such as through changes in design or design approach; (2) minimization of impact, by similar means; (3) compensation on-site, as in the same location of the impact; (4) compensation near-site, and in-kind, as in very close proximity to the impact site on the same waterway, and of the same or similar habitat type, or, if an alternative habitat type, one which will benefit the affected fish and wildlife resources; (5) off-site compensation, also in-kind; and (6) off-site compensation, out-of-kind, meaning a moderately or completely different habitat type, but preferably, a cover type which is as or more desirable than that being affected. Existing conservation banks, due to their siting and other factors, would be considered of relatively low priority in this scheme."

Following this scheme as a guide, the Service's first preference of the location for mitigation of TS_30_L impacts is Adjacent Corridor. This is closest to the impact site and would replace several functions not achievable with other options. This is the only option which would provide, as well as enhance, a direct corridor for wildlife movement between habitat at Tenmile Slough/Bulkley Cove and Fourteenmile Slough. Habitat in Adjacent Corridor would replace the buffer between the Brookside residential community and adjacent rice agriculture currently provided by habitat in the TS_30_L footprint. Disturbance of a portion of the site, with relocation of the drainage ditch, is already necessary for the construction of TS_30_L, so the additional work for restoration would be modest. In the long term, lateral groundwater movement due to proximity to the drainage ditch would presumably support the restoration. During the design high water event, riparian vegetation here might provide an increment of wave attenuation that could enhance flood protection. The sewer main and easement location, depth, and associated vegetation restrictions, would need to be assessed for consistency with restoration. If tall unmowed (or infrequently mowed) herbaceous vegetation were allowed in this easement, this might replace the value of the herbaceous/woody mixture of the current habitat at TS_30_L.

In general, habitat quality increases with unit size and width, which are limited in Adjacent Corridor by the narrow width of the allowed woodland. However, we noted that the TS_30_L impact site is also narrow and experiences apparently high wildlife use. Raptors seen on tall snags during the March 2021 site visit may be foraging in plowed fields near the site at that time of year, or in the herbaceous grassland patches within the site. Site specific factors not explicit in the HEP models which may attract wildlife to this site include the patch combination of dense shrub, herbaceous, and tree cover, nearby semi-perennial water, semi-perennial water of the drainage ditch, associated wetlands, aspect (west facing), or other factors. The Service would recommend mitigation similar to the HEP-derived 2.11:1 ratio (mitigation area:impact area) for the Adjacent Corridor, due to its similarity in landscape functions, very close proximity to the impact site, and potential to integrate restoration work with project construction.

The Kumar, Solari, and Pump Station sites are similar in their next nearest proximity to the impact site, and have a mixture of advantages and disadvantages on first impression. Both the Kumar and Pump Station sites have significant powerline easements that would likely limit habitat restoration underneath them in those areas. The Solari property has no such easements, but it is a smaller unit size. The Pump Station has the potential for contaminants in minor areas which would require at least assessment and possibly cleanup. All are more or less isolated sites which do not act as a corridor, although all are in the general proximity of the San Joaquin River or White Slough, which are potential wildlife corridors. The Service would recommend a slightly higher mitigation ratio for these sites, on the order of 2.5:1. Because one or more of these sites have a higher near term certainty of implementation than the others, and their proximity to the impact site, they are considered second preference to Adjacent Corridor.

Van Buskirk is more distant from the impact site, but has additional potential because it is close to a section of French Camp Slough near its confluence with the San Joaquin River, and also across the slough from the French Camp Mitigation Bank. This levee is heavily rocked and planned currently to be improved (raised, slurry wall) in place under the LSJRFS, but it could be set back or modified to provide a tidal connection. This would allow for water side vegetation (both wetlands and SRA cover) habitat at the land-water interface. Mitigation in the form of waterside vegetation and tidal connection would provide habitat values to the Delta and associated aquatic community. Although tidal habitats are not impacted by TS_30_L in particular, there are expected impacts to Delta tidal waters in other elements of the LSJRFS that do affect SRA cover and shallow water habitat generally. Actual habitat restoration area at Van Buskirk is likely to be partial due to other site uses, but still significant (~50-70 ac). If Van Buskirk were to be ready and available as mitigation for TS_30_L, the Service would recommend a lower mitigation ratio on the order of 2.0-2.5:1, with the lowest ratio associated with a setback design. However, due to distance from the impact site and lower certainty of near term implementation, it is considered third priority.

Manteca is the farthest from TS_30_L but it also is the largest in size of actual restorable habitat (150+ ac). It is far enough south that it is in the range of the listed riparian brush rabbit, which has been successfully propagated and introduced elsewhere on the west side of the San Joaquin River. Adequate water appears to be available through the existing agricultural infrastructure. This site, about a mile east of the San Joaquin River, would add to other habitat on Walthall Slough and the vicinity. Nevertheless, mitigating for impacts of TS_30_L, and likely other impacts within the LSJRFS so far away would have the adverse effect of consolidation (i.e., the formation of habitat voids by concentrating mitigation at one location, to offset impacts to widely distributed habitat). Here, mitigation would be at the south end of the LSJRFS, at the expense of impacted fragments and channel-associated riparian all to the north. Additionally, this particular site is also identified for habitat restoration under the Mossdale Tract Urban Flood Risk Reduction project (Mossdale UFRR) as an enhancement action. Although the Mossdale UFRR is in earlier planning and subject to change, the Service would need to further scrutinize the matter of changing the intent of enhancement to using it as mitigation for TS_30_L. Should Manteca ultimately be selected and ready for TS_30_L, the Service would recommend a higher mitigation ratio of at least 3:1. For these reasons, the Manteca site is considered fourth priority.

GENERAL RECOMMENDATIONS

1. Sequence: To ensure that the amount (area) of habitat is not reduced and, consistent with our general guidance, we recommend that mitigation be fully constructed and planted prior to the time of first impact. That is, if vegetation clearing and any associated elderberry transplantation for TS_30_L were done during the winter season to minimize impacts, the mitigation for those impacts should already be in place by the time of clearing.

2. Overall Mitigation Strategy: An overall strategy is recommended to incentivize early implementation and provide a mechanism for accounting impacts and mitigation. Because most sites are larger than needed for TS_30_L, any excess that is generated could potentially be used to offset impacts of future reaches of the LSJRFS. Mitigation ratios for future impacts will depend on the baseline habitat affected, the time that the excess mitigation has been in place, additional HEP study, and further coordination with the Corps expected as part of their development of an overall mitigation strategy.

3. Objectives: The Service will seek to achieve both (a) no net loss of in-kind habitat value, the resource category goal stated in Service (2016) as well as (b) no net loss of in-kind habitat area, for Resource Category 2 habitats. No net loss of area is justified when, as in this project area with its combined development for urban and agricultural uses, the habitat types are already rare and limited. This includes wetlands and riparian cover-types.

4. Mitigation Ratio: The recommended mitigation ratio will depend on the site, but should in no case be less than 2:1 on an area basis.

5. Listed Species compensation: To the extent possible, mitigation should include components of compensation for listed species, such as elderberry bushes for VELB, wetlands for giant garter snake, and habitats adjacent to tidal waters such as SRA cover and shallow water habitat for listed fishes.

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APPENDIX A: Excel Spreadsheet for HEP of TS_30_L

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	THIS IS THE "Models" TAB															
2																
3	This Excel Spreadsheet has seven TABS and calculates habitat value for the HEP sampling done at TS_30_L in December 2021												last edited 11/2/2022			
4	This first TAB starts includes a description of the seven TABs in this excel spreadsheet, and describes the models used															
5	Sampling dates: December 2, 3, 7, and 8, 2021															
6																
7																
8	TABS	Models: describes the variables, curves, and methods used														
9		HSIdatacalc: includes raw data from field datasheets, plot values for variables (V), associated suitability indicices (SI), and HSI														
10			also includes rough calculation of sampled area (all habitat area), and average HSIs which are used in futures													
11		Tree Hts:	includes raw data from field datasheets, plot averages in meters and feet, SI calculations for V1(rfct) and V3(rsg) variables models													
12		Species: includes list of species seen in each plot, as noted on field datasheets														
13		BasalArea: includes all direct measurements and estimations in field for basal area for each plot, and total calculations														
14		Futures: desktop exercise to assess mitigation area need; best professional opinion of best case and worst case scenario														
15			developed futures for each model; compared loss to existing; based on concurrent mitigation													
16		FuturesExcess: this tab is a scenario in which mitigation is set to begin at 10 years old at time of project impact														
17																
18		CAUTION: futures are best case, preliminary/subject to review/revision, actual habitat value may vary with mitigation timing, actual performance,														
19			as well as other factors not reflected in HEP models (e.g., adjacency to water/ag, connectivity, location/position on landscape, etc.)													
20																
21	Models chosen based on general characteristics, dominated by shrub/understory vegetation, some larger willows, a few larger trees															
22	snags suspected; high bird use noted in March 2021 site visit (raptors, songbirds, woodpeckers, hummingbirds, others);															
23	proximity to ag fields, water via ag drainage ditch, and separation from human activity (levee, restricted access) enhances wildlife use															
24																
25	1. modified Yellow Warbler (Schroeder 1982) - FWS "bluebook" model; derived from earlier Morse studies;															
26	V1- percent deciduous shrub crown cover, total as measured on two transects in each plot. Optimal at 60-80% cover															
27	note: herbaceous, including tall stiff herbaceous, are not included as shrub, that is, it is woody only; frequently estimated to nearest 5 or 10 feet.															
28	V2 - average height of deciduous shrub canopy, in meters; average of shrubs along or nearest to two transects. Optimal at 2+ meters.															
29	V3 - % deciduous shrub canopy cover composed of hydrophytic shrubs, ft cover along two transects converted to %. Min SI = 0.1; Max SI at 100% cover															
30	V4 - % cover of tall trees (> 30 feet tall), measured as the canopy greater than 30 feet over two transects in each plot															
31	Note: V4 is a modification, an added variable first developed by local sponsor in a 1988 HEP for the upper Guadalupe River															
32	The 1988 version had a minimum of zero for 0% tall trees, optimum of 1.0 from 50-75% tall trees, and decline to 0.75 at 100% tall trees															
33	This original modification was further modified in the 1998, USFWS HEP, to have a minimum value of 0.5 at 0% tall trees.															
34	This further modified model, with 4 variables was again used in the 2009 Reach 12 HEP on the Guadalupe River															
35	Use of tall trees, for occasional forage beats, or nest protection from cowbird parasitism, is consistent with yellow warbler observations															
36	since Morse and the 1982 Schroeder model, and is particularly applicable to yellow warbler populations in the western USA															
37																
38	HSI (yellow warbler modified) = (siV1 x siV2 x siV3 x V4)^1/2															
39																

2. Riparian Songbird Guild (Roberts 1986)

V1 - % shrub cover: by transect intercept method (feet cover of woody vegetation 1-3 m tall along transect/total transect length * 100)

V2 - % tree cover: by transect intercept method (feet cover of woody vegetation > 3m tall along transect/total transect length * 100)

V3 - average height of overstory trees: A minimum of 3 overstory trees were selected within each 300 x ~100 ft plot, and measured using a clinometer

In some instances, a clear line of sight to the treetop and tape could not be established, so these trees were estimated visually

note: clinometer and visual estimates are noted in the data sheets with "c" or "v"; clinometer estimates are in feet calculated from the slope angle

percentage multiplied by ground distance, however, these angles and distances are not recorded, only the height in feet

V4 - Canopy Layering Category: 1-none (SI=0); 2-shrubs only (SI=.25); 3=tall shrubs only (SI=.5); 4=trees only (SI=.75); 5=multiple layers (SI=1)

V5 - number of snags > 4 inches per acre: snags were identified for the entire plot, roughly 1/14 acre

assuming 300 ft X 100 ft wide plots (3000 sq ft), the suitability index is maximized by 1 snag observed in a plot

dead limbs of trees were counted as snags if at least breast height (4.5 feet) above the ground.

V6 - Percent of site in woody vegetation; this was measured directly by all woody vegetation over a transect ("feet woody" on data sheets)

note: herbaceous, including tall stiff herbaceous, are not included as shrub, that is, it is woody only; frequently estimated to nearest 5 or 10 feet.

HSI = {[(V1+ V2 + (2 X V3)/4)X V4]^0.5 + V5}*V6/2

3. Riparian Forest Cover type (USFWS. 2001. Sacramento Fish and Wildlife Office in-house model)

V1 - Average tree height, in feet; optimal at 60 feet and greater; same data as rip. songbird guild V3, converted to feet, different SI curve

V2 - Average canopy width of riparian trees, measured as intersection along transect across riparian zone. min SI = 0.2 at 30 or less ft; opt SI = 1 at 70+ ft.

field estimate by taking total transect length, and subtracting tape-measured outer herbaceous, if any.

V3 - Tree Canopy Closure, measured as percent of tree cover over transect; optimal at 60-80%; SI=0.8 at 100%, SI=0.0 at 0%

Note: 5M criterion (16.5 ft) for trees, so may not be same as rip. songbird guild variables V2 (tree cover, 3M+) or V6 (all woody cover, which includes shrubs)

Rationale is that low shrubs (1-3 M) are not considered "canopy", nor "tree"; notation made on all data sheets that rip. songbird guild V2 is to be used.

V4 - number of tree or shrub species; optimal at 4+ species; minimum value of 0.6 for 1 species

V5 - Average Understory Vegetative Density in %, this calculated from the feet of interception of vegetation at planes at 2, 6, and 14 feet, estimated at each transect

Note: One such overall estimate at each transect, then average of transects within a plot

A (non-native adjustment factor): If tree canopy dominated by non-natives, HSI is reduced by 40%, so A=.6; if native-dominated tree canopy, A = 1.0

B (separation from surface water): If riparian edge begins further than 20' from water, reduce by 1/3, so B=2/3; otherwise B =1.0 (not applied in this study)

HSI (riparian forest cover type) = A*B*(((siV1 * siV3 * siV4)^1/3 + (siV2 * siV5)^.5)/2)

4. Hairy Woodpecker (Sousa 1987)

Note: model applicability states a minimum of 4 ha (~11 acres) of habitat and 40 M width, marginal for TS_30_L, but other forested habitat is present south.

Note: variables V1-3 measured with Biltmore stick

V1	snags>25cm/acre	optimized at 2+/acre; due to rarity of this size snag, and use in nesting, average of all plots is applied for this variable (total ~1.4 ac)
V2	nest component; SI=0 at >8", 1.0 at 16+"; mean dbh of overstory tree; overstory trees in each plot as could be reasonably estimated;	
V3	cover component; SI=.5<6", 1.0>10"; mean dbh of overstory tree; plot specific as with V2	
V4	% tree canopy cover; from trees 6+M, above songbird guild/RFCT models; coarse estimate (nearest 5-10% or feet recorded)	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
79	HSI = (V1 +.75V2) X (V3 X V4)															
80																
81	5. Downy Woodpecker (USFWS. 1983. FWS/OBS-82/10.38)															
82	V1 - Basal area; at 4.5' height, optimal (SI=1) from 10-20 sq M/hectare (2.71 ac), SI=0 at 0 basal area; SI=.5 at 30+sq M.															
83	Note: alternative method to cruz-all needed for this study due to obscured visibility from shrubs, did stem count/diameter coarse estimate of basal area of entire plot															
84	V2 - density of snags > 6" in diameter, per acre; optimal at 5+ snags/acre															
85		optimized at 5+/acre; due to use in nesting, average of all plots is applied for this variable (total ~1.4 ac for 21 plots)														
86	Note: a constant snag density is used (all plots) with a plot-specific basal area															
87																
88	HSI (downy woodpecker) = the mininum SI of V1 and V2															

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	THIS IS THE "HSIdatacalc" TAB															
2	Yellow Warbler Modified															
3	note: for V3, essentially all deciduous shrub canopy cover is by hydrophytic species, thus V3 = 1.0 unless specified otherwise															
4	Plot	1		2		3		4		5		6		7		
5	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
6	length	65	100	100	100	120	100	100	100	100	100	100	100	100	100	
7	feet dsc	18	79	72	82	60	100	50	90	90	100	70	90	90	90	
8	V1trans	0.28	0.79	0.72	0.82	0.5	1	0.5	0.9	0.9	1	0.7	0.9	0.9	0.9	
9	V1avg	0.59		0.77		0.73		0.70		0.95		0.80		0.90		
10	SI(V1)avg	0.98		1.00		1.00		1.00		0.70		1.00		0.80		
11	V2	2		2		2		1.6	2	1.88	1.92	1.45	1.5	1.79		
12	V2avg	2		2		2		1.8		1.9		1.475		1.79		
13	SI(V2)	1.00		1.00		1.00		0.80		0.94		0.73		0.90		
14	V3	1.00		1.00		1.00		1.00		1.00		1.00		1.00		
15	SI(V3)	1.00		1.00		1.00		1.00		1.00		1.00		1.00		
16	V4	0	0	0	0	0.6	0.1	0.6	0.1	0.3	0.3	0	0.3	0	0.2	
17	V4avg	0		0		0.35		0.35		0.3		0.15		0.1		
18	SI(V4)	0.5		0.5		1		1		0.8		0.5		0.5		
19																
20	HSI-ywmod	0.70		0.71		1.00		0.89		0.73		0.60		0.60		
21	HSI-yworig	0.99		1.00		1.00		0.89		0.81		0.85		0.85		
22																
23	Plot	8		9		10		11		12		13		14		
24	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
25	length	100	100	60	50	100	100	100	100	100	100	100	100	100	100	
26	feet dsc	85	100	60	50	60	100	90	100	95	75	80	80	77	74	
27	V1trans	0.85	1	1	1	0.6	1	0.9	1	0.95	0.75	0.8	0.8	0.77	0.74	
28	V1avg	0.93		1.00		0.80		0.95		0.85		0.80		0.76		
29	SI(V1)avg	0.75		0.60		1.00		0.70		0.90		1.00		1.00		
30	V2	1.76	1.88	1.6	2	2	1.8	1.6	2	2	2	1.1	2	1.65	1.22	
31	V2avg	1.82		1.8		1.9		1.8		2		1.55		1.435		
32	SI(V2)	0.88		0.80		1.00		0.80		1.00		0.55		0.83		
33	V3trans	1.00	1.00	1.00	1.00	1.00	1.00	0.40	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
34	V3avg	1.00		1.00		1.00		0.70		1.00	1.00	1.00		1.00		
35	SI(V3)avg	1.00		1.00		1.00		0.73		1.00		1.00		1.00		
36	V4	0	0	0	0	0	0.1	0.2	0	0.2	0	0	0	0.2	0	
37	V4avg	0		0		0.05		0.1		0.1		0		0.1		
38	SI(V4)	0.5		0.5		0.5		0.7		0.7		0.5		0.7		
39																
40	HSI-ywmod	0.57		0.49		0.71		0.53		0.79		0.52		0.76		
41	HSI-yworig	0.81		0.69		1.00		0.64		0.95		0.74		0.91		
42																
43	Plot	15		16		17		18		19		20		21		

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
44	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
45	length	100	100	150	120	100	100	80	75	100	90	80	80	80	80	
46	feet dsc	50	50	135	90	50	85	60	30	30	0	45	60	75	60	
47	V1	0.50	0.5	0.9	0.75	0.5	0.85	0.75	0.4	0.3	0	0.5625	0.75	0.9375	0.75	
48	V1avg	0.50		0.83		0.68		0.58		0.16		0.66		0.84		
49	SI(V1)avg	0.83		0.93		1.00		0.97		0.26		1.00		0.91		
50	V2	0.5	0.81	2	1.466667	1.75	1.647059	2	2	1.25	0	2	1.8	2	1.75	
51	V2avg	0.655		1.733333		1.698529		2		0.625		1.9		1.875		
52	SI(V2)	0.25		1.00		0.88		1.00		0.63		1.00		1.00		
53	V3	1.00	1.00	1.00	1.00	1.00	1.00	0.40	1.00	1.00	0.00	1.00	1.00	1.00	0.69	
54	V3avg	1.00		1.00		1.00		0.70		0.50	0.10	1.00		0.84		
55	SI(V3)avg	1.00		1.00		1.00		0.73		0.55		1.00		0.86		
56	V4	0	0	0	0.1	0	0	0	0.533333	0	0	0	0	0	0.2	
57	V4avg	0		0.05		0		0.266667		0		0		0.1		
58	SI(V4)	0.5		0.5		0.5		0.5		0.5		0.5		0.5		
59																
60	HSI-ywmod	0.32		0.68		0.66		0.59		0.21		0.71		0.63		
61	HSI-yworig	0.46		0.97		0.94		0.84		0.30		1.00		0.89		
62																
63	Riparian Songbird Guild															
64	note: for variables V1 and V2, these are considered non overlapping, as "trees" being >3M only generally have lower limbs that go 1-3M as well															
65	note: this non-overlapping assumption may modestly underestimate foliage SIs and overall HSI but is deemed appropriate for this site															
66	note: V4 is the maximum, not the average, of both transects, considering that multiple layers anywhere in a plot applies															
67	Plot	1		2		3		4		5		6		7		
68	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
69	length	65	100	100	100	120	100	100	100	100	100	100	100	100	100	
70	ftshrub<3m	18	79	77	82	60	100	50	90	90	100	40	45	30	30	
71	V1	27.69230769	79	77	82	50	100	50	90	90	100	40	45	30	30	
72	V1avg	53.34615385		79.5		75		70		95		42.5		30		
73	SI(V1)avg	1.00		1.00		1.00		1.00		0.63		0.81		0.50		
74	fttree>3m	12	70	77	82	80	80	20	70	80	80	50	55	70	60	
75	V2	18.46153846	70	77	82	66.66667	80	20	70	80	80	50	55	70	60	
76	V2avg	44.23		79.5		73.33333		45		80		52.5		65		
77	SI(V2)avg	0.21		1		1		0.25		1		1		1		
78	V3	7.66		7.10		10.8966		13.716		8.5344		9.492343		5.7912		
79	SI(V3)	1		1		1		1		1		1		0.95824		
80	V4	5	5	5	5	5	5	5	5	5	5	5	5	5	5	
81	V4max	5.00		5.00		5.00		5.00		5.00		5.00		5.00		
82	SI(V4)max	1		1		1		1		1		1		1		
83	snags>4"	1		3		1		4		0		1		6		
84	V5	1.76		4.356		1.32		5.808		0		1.452		8.712		
85	SI(V5)	0.59		1.00		0.44		1.00		0.00		0.48		1.00		
86	allwoodyft	18.00	79	77.00	82	120.00	90	70.00	90	90.00	100	70.00	90	90.00	90	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
87	V6%allwoody	27.69	79.00	77.00	82.00	100.00	90.00	70.00	90.00	90.00	100.00	70.00	90.00	90.00	90.00	
88	V6avg	53.35		79.50		95.00		80.00		95.00		80.00		90.00		
89	SI(V6)avg	0.51		0.78		0.95		0.79		0.95		0.79		0.89		
90																
91	HSI-rsg	0.38		0.78		0.68		0.75		0.45		0.58		0.86		
92																
93	Plot	8		9		10		11		12		13		14		
94	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
95	length	100	100	60	50	100	100	100	100	100	100	100	100	100	100	
96	ftshrub<3m	40	25	60	0	30	60	40	100	65	40	80	80	32	40	
97	V1	40	25	100	0	30	60	40	100	65	40	80	80	32	40	
98	V1avg	32.5		50		45		70		52.5		80		36		
99	SI(V1)avg	0.56		1.00		0.88		1.00		1.00		1.00		0.65		
100	fttree>3m	60	75	0	40	70	40	40	0	30	30	5	5	45	30	
101	V2	60	75	0	80	70	40	40	0	30	30	5	5	45	30	
102	V2avg	67.50		40		55		20		30		5		37.5		
103	SI(V2)avg	1.00		0.75		1.00		0.25		0.50		0.00		0.69		
104	V3	8.26		7.62		6.096		8.382		6.477		7.112		6.2992		
105	SI(V3)	1		1		1		1		1		1		1		
106	V4	5		5		5	5	5	5	5	5	5	5	5		
107	V4max	5.00		5.00		5.00		5.00		5.00		5.00		5.00		
108	SI(V4)max	1		1		1		1		1		1		1		
109	snags>4"	2		0		1		3		4		4		3		
110	V5	2.904		0		1.452		4.356		5.808		5.808		4.356		
111	SI(V5)	0.97		0.00		0.48		1.00		1.00		1.00		1.00		
112	allwoodyft	85	100	60	50	100	100	100	100	100	75	85	85			
113	V6%allwoody	85	100	100	100	100	100	100	100	100	75	85	85	77	74	
114	V6avg	92.50		100.00		100.00		100.00		87.50		85.00		75.50		
115	SI(V6)avg	0.92		1.00		1.00		1.00		0.87		0.84		0.74		
116																
117	HSI-rsg	0.88		0.48		0.73		0.95		0.84		0.79		0.71		
118																
119	Plot	15		16		17		18		19		20		21		TEST
120	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
121	length	100	100	150	120	100	100	80	75	100	90	80	80	80	80	
122	ftshrub<3m	40	30	10	60	35	85	40	29	30	0	20	40	30	20	
123	V1	40	30	6.666667	50	35	85	50	38.66667	30	0	25	50	37.5	25	
124	V1avg	35		28.33333		60		44.33333		15		37.5		31.25		
125	SI(V1)avg	0.63		0.46		1.00		0.86		0.13		0.69		0.53		1
126	fttree>3m	0	20	130	30	10	30	20	50	0	0	25	20	45	55	
127	V2	0	20	86.66667	25	10	30	25	66.66667	0	0	31.25	25	56.25	68.75	
128	V2avg	10.00		55.83333		20		45.83333		0		28.125		62.5		
129	SI(V2)avg	0.00		1.00		0.25		0.90		0.00		0.45		1.00		1

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
130	V3	8.26		7.18		7.3152		9.0424		5.588		8.1788		6.94944		
131	SI(V3)	1		1		1		1		0.9176		1		1		1
132	V4	1	5	5	5	5	5	5	5	2	1	5	5	5	5	
133	V4max	5.00		5.00		5.00		5.00		2.00		5.00		5.00		
134	SI(V4)max	1		1		1		1		0.25		1		1		1
135	snags>4"	4		2		1		2		4		1		1		
136	V5	5.808		2.151111		1.452		3.747097		6.113684		1.815		1.815		
137	SI(V5)	1.00		0.72		0.48		1.00		1.00		0.61		0.61		1
138	allwoodyft	50	50	135	90	50	85	60	65	30	0	45	60	75	75	
139	V6%allwoody	50	50	90	75	50	85	75	87	30	0	56	75	94	94	
140	V6avg	50.00		82.50		67.50		80.83		15.00		65.63		93.75		
141	SI(V6)avg	0.47		0.82		0.66		0.80		0.11		0.64		0.93		1
142																
143	HSI-rsg	0.43		0.67		0.46		0.79		0.07		0.48		0.72		1.00
144																
145	Riparian Forest Cover Type															
146	note: V1 is in feet; V2 is feet over transect; V3 is % estimate over transect; V5 is % visual estimate over transect, at 3 planes, averaged, recorded on datasheet (entered here)															
147	Plot	1		2		3		4		5		6		7		
148	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
149	length	65	100	100	100	120	100	100	100	100	100	100	100	100	100	
150	V1treehtft	21		23		21		27		24		24		30		
151	SI(V1-RFCT)	0.35		0.39		0.34		0.45		0.39		0.40		0.49		
152	V2ripwdthft	20	80	77	82	120	100	100	90	90	100	85	90	90	90	
153	V2avg	50		79.5		110		95		95		87.5		90		
154	SI(V2-RFCT)	0.6		1		1		1		1		1		1		
155	V3canopy%	0	20	20	0	80	50	20	70	80	80	5	50	60	40	
156	V3avg	10		10		65		45		80		27.5		50		
157	SI(V3-RFCT)	0.2		0.2		1		0.9		1		0.55		1		
158	V4#spp	4		3		4		5		4		4		5		
159	SI(V4-RFCT)	1		0.9		1		1		1		1		1		
160	V5undstry	5	55	60	70	50	85	40	75	90	90	60	75	80	55	
161	V5avg	30		65		67.5		57.5		90		67.5		67.5		
162	SI(V5-RFCT)	1.00		0.94		0.91		1.00		0.63		0.91		0.91		
163	Nnadjfctr	1		1		1		1		1		1		1		
164																
165	HSI-RFCT	0.59		0.69		0.83		0.87		0.76		0.78		0.87		
166																
167	Plot	8		9		10		11		12		13		14		
168	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
169	length	100	100	60	50	100	100	100	100	100	100	100	100	100	100	
170	V1treehtft	23.5		25		20		27.5		21.25		23.33333		20.66667		
171	SI(V1-RFCT)	0.39		0.42		0.33		0.46		0.35		0.39		0.34		
172	V2ripwdthft	85	100	60	50	100	100	100	100	100	100	100	100	100	100	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
173	V2avg	92.5		55		100		100		100		100		100		
174	SI(V2-RFCT)	1		0.7		1		1		1		1		1		
175	V3canopy%	50	30	0	25	90	30	40	0	20	30	5	0	40	30	
176	V3avg	40		12.5		60		20		25		2.5		35		
177	SI(V3-RFCT)	0.8		0.25		1		0.4		0.5		0.05		0.7		
178	V4#spp	5		4		5		3		4		5		7		
179	SI(V4-RFCT)	1		1		1		0.9		1		1		1		
180	V5undstry	70	70	50	80	90	80	60	60	60	70	35	35	55	30	
181	V5avg	70		65		85		60		65		35		42.5		
182	SI(V5-RFCT)	0.88		0.94		0.69		1.00		0.94		1.00		1.00		
183	Nnadjfctr	1		1		1		1		1		1		1		
184																
185	HSI-RFCT	0.81		0.64		0.76		0.77		0.76		0.63		0.81		
186																
187	Plot	15		16		17		18		19		20		21		
188	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
189	length	100	100	150	120	100	100	80	75	100	90	80	80	80	80	
190	V1treehtft	27		24		24		30		18		27		23		
191	SI(V1-RFCT)	0.45		0.39		0.40		0.49		0.31		0.45		0.38		
192	V2ripwdthft	90	60	135	90	65	75	60	70	50	0	45	60	75	80	
193	V2avg	75		112.5		70		65		25		52.5		77.5		
194	SI(V2-RFCT)	1		1		1		0.9		0.2		0.65		1		
195	V3canopy%	0	0	135	90	5	35	20	65	0	0	20	10	50	62.5	
196	V3avg	0		112.5		20		42.5		0		15		56.25		
197	SI(V3-RFCT)	0		0.59375		0.4		0.85		0		0.3		1		
198	V4#spp	7		6		2		5		6		6		6		
199	SI(V4-RFCT)	1		1		0.8		1		1		1		1		
200	V5undstry	15	30	85	40	30	65	40	40	25	0	45	50	75	50	
201	V5avg	22.5		62.5		47.5		40		12.5		47.5		62.5		
202	SI(V5-RFCT)	0.80		0.97		1.00		1.00		0.53		1.00		0.97		
203	Nnadjfctr	1		1		1		1		1		1		1		
204																
205	HSI-RFCT	0.45		0.80		0.72		0.86		0.37		0.72		0.85		
206																
207	Downy Woodpecker															
208	see BasalArea TAB of this spreadsheet for V1, SI(V1-dw) calculations															
209	Plot:	1	2	3	4	5	6	7	8	9	10					
210	SI(V1-dw)	0.27	1.00	0.99	0.50	0.50	0.80	0.19	0.05	0.16	1.00					
211	plot 10"snag	1	3	1	2	0	1	6	0	0	1					
212	V2-snag/ac	1.5	4.4	1.5	2.9	0.0	1.5	8.7	0.0	0.0	1.5					
213	SI(V2-dw)	0.29	0.87	0.29	0.58	0.00	0.29	1.00	0.00	0.00	0.29					
214	HSI-dw	0.27	0.87	0.29	0.50	0.00	0.29	0.19	0.00	0.00	0.29					
215																

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
216	Plot:	11	12	13	14	15	16	17	18	19	20	21				
217	SI(V1-dw)	0.20	0.74	0.71	0.16	0.34	0.59	0.77	0.30	0.14	0.78	0.71				
218	plot 10"snag	3	3	0	2	2	1	0	1	1	0	0				
219	V2-snag/ac	4.4	4.4	0.0	2.9	2.9	1.5	0.0	1.5	1.5	0.0	0.0				
220	SI(V2-dw)	0.87	0.87	0.00	0.58	0.58	0.29	0.00	0.29	0.29	0.00	0.00				
221	HSI-dw	0.20	0.74	0.00	0.16	0.34	0.29	0.00	0.29	0.14	0.00	0.00				
222																
223	Test calculation (average snag density)			1.16			Test calculation (average basal area)				38.14					
224	associated snag SI(V1-dw)			0.23			associated BA SI(V2-dw)				0.87					
225	Test calculation, HSI-dw from average snag and BA				0.23											
226	Test calculation, HSI-dw as average HSI across plots				0.23											
227																
228	Hairy Woodpecker															
229	see BasalArea TAB of this spreadsheet for V1-hw (DbH of overstory trees) calculations															
230	Plot:	1	2	3	4	5	6	7	8	9	10					
231	trans1length	65	100	120	100	100	100	100	100	60	100					
232	trans2length	100	100	100	100	100	100	100	100	50	100					
233	plot10"snag	1	2	0	0	0	0	3	0	0	0					
234	V1-snag/ac	1.5	2.9	0.0	0.0	0.0	0.0	4.4	0.0	0.0	0.0					
235	SI(V1-hw)	0.29	0.58	0.00	0.00	0.00	0.00	0.87	0.00	0.00	0.00					
236	meandbhov	8.8	1.0	13.8	8.8	4.7	6.5	12.5	6.0	1.3	12.5					
237	SI(V2-hw)	0.11	0.00	0.83	0.11	0.00	0.00	0.65	0.00	0.00	0.65					
238	SIN	0.37	0.58	0.63	0.09	0.00	0.00	1.36	0.00	0.00	0.48					
239	Testcalc SINavgsng	0.26	0.18	0.80	0.27	0.18	0.18	0.66	0.18	0.18	0.66					
240	SI(V3-hw)	0.86	0.50	1.00	0.87	0.50	0.57	1.00	0.51	0.50	1.00					
241	cancovtree1	10	20	80	20	60	0	60	50	0	15					
242	cancovtree2	25	20	20	50	70	30	30	25	25	25					
243	cancovtree%total	21	20	45	35	65	15	45	38	23	20					
244	SI(V4-hw)	0.09	0.07	0.44	0.29	0.71	0.00	0.43	0.32	0.11	0.07					
245	SIC	0.08	0.04	0.44	0.25	0.36	0.00	0.43	0.16	0.06	0.07					
246	HSI(hw)	0.03	0.02	0.27	0.02	0.00	0.00	0.58	0.00	0.00	0.03					
247	testcalc HSIavgsng	0.02	0.01	0.35	0.07	0.06	0.00	0.28	0.03	0.01	0.05					
248																
249	Test calculation: average snag density =			0.90												
250	Test calculation: average SI(V1-hw)=			0.18												
251	using avg snagSI															
252																
253	Plot:	11	12	13	14	15	16	17	18	19	20	21				
254	trans1length	100	100	100	100	100	150	100	80	100	80	80				
255	trans2length	100	100	100	100	100	120	100	75	90	80	80				
256	plot10"snag	3	2	0	0	1	1	0	0	0	0	0				
257	V1-snag/ac	4.4	2.9	0.0	0.0	1.5	1.5	0.0	0.0	0.0	0.0	0.0				
258	SI(V1-hw)	0.87	0.58	0.00	0.00	0.29	0.29	0.00	0.00	0.00	0.00	0.00				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
259	meandbhov	5.0	12.5	14.0	7.7	12.5	25.0	12.3	17.0	5.7	17.9	10.6				
260	SI(V2-hw)	0.00	0.65	0.86	0.00	0.65	1.00	0.62	1.00	0.00	1.00	0.37				
261	SIN	0.87	1.07	0.65	0.00	0.78	1.04	0.46	0.75	0.00	0.75	0.28				
262	Testcalc SINavgsng	0.18	0.66	0.83	0.18	0.66	0.93	0.64	0.93	0.18	0.93	0.46				
263	SI(V3-hw)	0.50	1.00	1.00	0.72	1.00	1.00	1.00	1.00	0.50	1.00	1.00				
264	cancovtree1	30	20	0	30	0	10	0	15	0	0	10				
265	cancovtree2	0	20	0	20	10	20	25	40	0	5	40				
266	cancovtree%total	15	20	0	25	5	11	13	35	0	3	31				
267	SI(V4-hw)	0.00	0.07	0.00	0.14	0.00	0.00	0.00	0.29	0.00	0.00	0.23				
268	SIC	0.00	0.07	0.00	0.10	0.00	0.00	0.00	0.29	0.00	0.00	0.23				
269	HSI(hw)	0.00	0.08	0.00	0.00	0.00	0.00	0.00	0.22	0.00	0.00	0.06				
270	testcalc HSIavgsng	0.00	0.05	0.00	0.02	0.00	0.00	0.00	0.27	0.00	0.00	0.11				
271																
272	Test calculation (average snag density)			0.90												
273	associated snag SI(V1-hw)			0.18												
274																
275	Summary of HEP:	HSImean	HSImax	HSImin												
276	Model															
277	YellowWarblerMod	0.64	1.00	0.21												
278	YellowWarblerOrig	0.83	1.00	0.30												
279	RipSongbirdGuild	0.64	0.95	0.07												
280	RipForestCovertyp	0.73	0.87	0.37												
281	DownyWoodpckr	0.23	0.87	0.00												
282	HairyWoodpckr	0.06	0.58	0.00												
283	Hwtestcalcavgsnag	0.06	0.35	0.00												
284																
285	Area estimate (rough, average width X 300 ft, summed)															
286	Plot	1		2		3		4		5		6		7		
287	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
288	length	65	100	100	100	120	100	100	100	100	100	100	100	100	100	
289	area, acres	0.57		0.69		0.76		0.69		0.69		0.69		0.69		
290	Plot	8		9		10		11		12		13		14		
291	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
292	length	100	100	60	50	100	100	100	100	100	100	100	100	100	100	
293	area, acres	0.69		0.38		0.69		0.69		0.69		0.69		0.69		
294	Plot	15		16		17		18		19		20		21		
295	transect	1	2	1	2	1	2	1	2	1	2	1	2	1	2	
296	length	100	100	150	120	100	100	80	75	100	90	80	80	80	80	
297	area, acres	0.69		0.93		0.69		0.53		0.65		0.55		0.55		

	A	B	C	D	E	F	G	H	I	J	K	L	M
1	THIS IS THE "TreeHts" TAB												
2	Tree height calculation for Riparian Songbird model, variable V3; Riparian Forest Cover Type model variable V1												
3	for December 2021 HEP of Lower San Joaquin River Feasibility Study, Reach TS_30_L												
4	note: method identifier c, refers to clinometer, calculated in field; v means visual estimate by eye												
5	note: some numbers represent "synthetic" values to reflect visual estimates recorded on data sheets and verified by photos												
6	Data sheet:		1	2	3	4	5	6	7	8	9	10	11
7			14	55	30	55	29	53	10	20	25	18	30
8			60	16	47	35	30	25	10	21	25	22	25
9			20	16	25		25	26	10	30			30
10			22	18	41			27	40	25			25
11			20	18				28	30	20			
12			20	20				29	18	25			
13			20	20				30	15				
14	Ht feet (V1 RFCT)		25.1	23.3	35.8	45.0	28.0	31.1	19.0	23.5	25.0	20.0	27.5
15	Ht meters (V3 RSG)		7.7	7.1	10.9	13.7	8.5	9.5	5.8	7.2	7.6	6.1	8.4
16													
17	Data sheet:		12	13	14	15	16	17	18	19	20	21	
18			33	38	25	25	15	30	45	21	18	20	
19			20	25	25	25	12	35	25	14	22	18	
20			20	14	20	30	35	20	25	15	48	35	
21			20	20	20	22	22	20	40	20	28	20	
22			20	30	20	22	40	44	25	13	25		
23			20			12	25	20		18			
24			25			55		20		20			
25						40		20		25			
26						25		20					
27								20					
28								20					
29								25					
30								25					
31													
32	Ht feet (V1 RFCT)		21.3	23.3	20.7	27.1	23.6	24.0	29.7	18.3	26.8	22.8	
33	Ht meters (V3 RSG)		6.5	7.1	6.3	8.3	7.2	7.3	9.0	5.6	8.2	6.9	

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O
1	THIS IS THE "Species" TAB														
2	This TAB records the species observed in each plot:														
3	Plot:	1		2		3		4		5		6		7	
4		BB		BB		BB		BB		BB		BB		buttonwillow	
5		ash		willow		willow		red willow		red willow		willow		BB	
6		willow		buttonwillow		buttonwillow		silver willow		silver willow		elderberry		red willow	
7		unk. compd leaf				walnut		buttonwillow		buttonwillow		silver willow		unid hanging seed	
8								walnut						green unid Fig?	
9															
10	Plot:	8		9		10		11		12		13		14	
11		buttonwillow		buttonwillow		BB		california rose		buttonwillow		buttonwillow		BB	
12		red willow		red willow		buttonwillow		willow		BB		hackberry		silver willow	
13		silver willow		compnd leaf unid		unid willow		BB		red willow		silver willow		red willow	
14		BB		red oak seedling		red willow				valley oak		red willow		unid	
15		Fig				elderberry						unk brownfuzzybush		compnd leaf unid	
16						unid near top								unk brownfuzzybush	
17														buttonwillow	
18															
19	Plot:	15		16		17		18		19		20		21	
20		red willow		silver willow		buttonwillow		willow		valley oak		willow1		pecan	
21		BB		live oak		silver willow		buttonwillow		willow		willow2		valley oak	
22		buttonwillow		buttonwillow				valley oak		2nd willow spp		BB		willow	
23		2nd willow spp		BB				BB		unid treewithgalls		pecan		BB	
24		cork oak		coyote bush				2nd willow spp		fig		live oak		unid hanging seed	
25		black locust		walnut						live oak		valley oak		live oak	
26		walnut								BB					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
1	THIS IS THE "BasalArea" TAB															
2	Note: Basal Area was determined from DbH measurements of larger trees, plus estimates of stem number X approximate DbH of dense stems															
3	this calculation can be seen in the cells for rows "BA ft/ac", recorded exactly as noted in field on data sheets.															
4	Note: overstory trees shown in bold															
5	Note: plots 2, 4, and 5, were not done by stem count due to extremely high willow density, in these plots, estimated 3 or 6 inches															
6		per square yard (9 sq ft), and applied that density to the shrub portion of the plot, that is 300 ft x shrub cover in V1-yellow warbler model														
7		to get an estimate of basal area in feet, per acre														
8	Note: missing data/not measured in plot 10, so assumed 3"/yard X 50 ft shrub cover average / 9 ft per yard x (30,000 plot size/43,560 sq ft per acre)															
9		estimate based on field photos 196, 197, 198														
10	Note: some plots (2,4,5) where average stem densities per square meter were included, yielded very large basal areas, and may be overestimates															
11	NOTE: 4/15/22 - SOME BASAL AREAS ARE MISRECORDED AS SUM OF DIAMETERS, THESE INDIVIDUAL DIAMETERS MUST BE CONVERTED TO AREAS BEFORE SUMMING															
12	NOTE: 4/27/22 - ALL BASAL AREAS CHECKED, RECALCULATED, RESUME EDITING 6/24/22															
13	Plot:	1	2	3	3-BA sq ft	4	5	6	7	8	9	10				
14		**9**	8000	**26**	**3.687008**	**30**	**4**	**20**	**10**	**6**	**8**	**15**				
15		**10**		**16**	**1.396263**	**7**	**4**	**6**	**15**	**6**	**20**	**10**				
16		**10**		**16**	**1.396263**	**4**	**6**	**6**		**6**	**10**					
17		**6**		**16**	**1.396263**	**4**		**6**		**6**	**10**					
18				**14**	**1.069014**	**6**		**6**		**6**	**8**					
19				**4**	**0.087266**	**6**		**6**		**6**						
20				**4**	**0.087266**	**8**		**6**		**6**						
21				**11**	**0.659953**	**7**		**6**								
22				**15**	**1.227185**	**6**		48								
23				**16**	**1.396263**	**10**										
24				60												
25						14000	16000				40					
26					12.40275											
27	Basal Area estimation notes for plots 1-10:															
28	Note: all square inches linear converted to square feet by dividing by 144															
29	plot 1: estimate wooded northern half of site is 8" per 100 sq ft, or 960" (80') BA, site area is ~.57 ac (300*(65+100/2)															
30		1/2 of site is 150 x 80 feet wide = 12,000 sq ft so if 8" per 100 feet, that is 960" BA (or 960/144= 6.7 sq ft) in whole plot.											BA per ac = 6.7/.57=11.7'			
31	plot 2: note estimate wooded area, 80% of site (24,000 sq ft, 2667 sq yds) has 3"(3/144 = .0208') BA per yard, or 667 sq ft BA; 43560/30000*55.5=80.5'/ac BA															
32	plot 3: data sheets recorded 10 tree diameters, and "2x20 - 2x40" notation, meaning 2" X 20 to 40 willow shrubs, and "est, several feet/10th acre"															
33		Total for trees only is 12.4 ft sq; but if est, above is for willows, that is 3 ft/tenth acre is 30 sq feet/ac BA; overall guess 43.4/ac BA														
34	plot 4: data sheet notes "likely high, 6" per sq M", which is 0.0417sq ft; assuming 80% (average of "all woody", RSG V6) reduces this to 0.033 ft BA per 9 sq ft															
35		.033 ft/sq M ~.033 ft/9 sq ft; expanding to an acre 0.033/9*43560 sq ft/ac = 161.5'/ac BA														
36	plot 5: data sheet notes " est thick willow stems 6" per sq M + trees. Likely high [BA]." This would calculate out to at least plot 4, or more; 161.5' ac BA															
37																
38	plot 6: data notes "15 willows x 6" = 90 sq in trees alone + willows; dense willows 1/3 site 6+"/sqM"; 20" willow, willow 6-8 stems 6"															
39		species	diameter	BA	assumption											

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
40		willow	6	1.374447	7 stems this size											
41		willow	20	2.181662												
42		thicket		20.83333	((100x45/9)x 6)/144 =			20.83333								
43		total BA in plot		24.38944		total per acre		35.41347								
44		(300 x45/9)/3x 6/144=46.3 sq ft BA in 30,000 sq ft site. 46.3*43560/30000=67.2/ac BA														
45	plot 7: data notes "4-6"/10 sq M for 1/2 site; 0"/sq M [for other 1/2?]";															
46		data note calculation, assume "10 sq M" is 90sqft, not 900.														
47		so overall is 2"/sqM; 2"/144=.014'; .014/9*43560=67.8'/ac BA														
48		overall average of "4-6" and zero, is 2.5", (5+0)/2														
49		estimate calculation of BA per sq ft, therefore, is (2.5/144)/90						0.000193								
50		the BA for 1 acre is the above per foot x 43560						8.402778								
51		this was one of the few sites with a cruz-all estimate, 2 x 5 BAF, or 10'/ac BA														
52		select the lower of the two estimates for the HEP														
53	plot 8: notes say "not possible ~1 x 5?", in likely reference to a cruz-all measurement; the seven, 6" trees are 28" BA each or 196" total															
54		169"/144=1.36 sq ft in the plot. 1.36*43560/30000=1.98'/ac BA														
55	plot 9:	notes indicate 10, 4" stems; thats pi x 2 squared,x 10, or 125.6 inches or 0.872' BA in plot (125.6/144); 0.872*43560/30000=1.27/ac BA														
56		individual trees measured additionally														
57		species	diameter	BA	assumption											
58		ash	8	0.349066												
59		buttonW	20	2.181662	multiple stems of same species											
60			10	0.545415												
61			10	0.545415												
62			8	0.349066												
63		total BA in plot		3.970624		total per acre		5.765346	plus 1.27 above =		7.035346					
64	plot 10: "missing data", post field photo interp: min 2" dia/yd=(~3" BA) per yard x 50' wooded x 300' long /144 sq in per ft)/9 ft per yd *43560/30000 = 50.4'/ac BA															
65	Plot:	1	2	3	4	5	6	7	8	9	10					
66	meanDbH	8.8	1.0	13.8	8.8	4.7	6.5	12.5	6.0	1.3	12.5					
67	BA ft/ac	11.7	80.5	43.4	161.5	161.5	35.4	8.4	2.0	7.0	50.4					
68	SI(V1-dw)	0.27	1.00	0.99	0.50	0.50	0.80	0.19	0.05	0.16	1.00					
69																
70	Plot:	11	12	13	14	15	16	17	18	19	20	21				
71		**6**	**14**	**10**	**4**	**16**	**16**	**8**	**14**	**6**	**11**	**15**				
72		**6**	**13**	**9**	**18**	**8**	**29**	**8**	**12**	**5**	**18**	**10**				
73		**4**	**32**	**12**	**6**	**13**	**30**	**8**	**18**	**6**	**34**	**8**				
74		**3**	**4**	**8**	**6**	**8**		**20**	**16**		**22**	**11**				
75		**3**	**4**	**10**	**6**	**7**		**12**	**25**		**28**	**21**				
76		**8**	**8**	**15**	**6**	**23**		**6**			**26**	**11**				
77				**30**				**24**			**22**	**9**				
78				**18**							**6**	**9**				

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
79											**6**	**9**				
80											**6**	**8**				
81												**8**				
82												**8**				
83	meanDbH	5.0	12.5	14.0	7.7	12.5	25.0	12.3	17.0	5.7	17.9	10.6				
84	BA ft/ac	8.6	32.7	31.1	6.9	15.0	26.1	33.9	13.1	6.2	34.2	31.1				
85	SI(V1-dw)	0.20	0.74	0.71	0.16	0.34	0.59	0.77	0.30	0.14	0.78	0.71				
86	Basal Area estimation notes for plots 11-21:															
87	plot 11: notes for this plot have a list of species and diameters, and a guess of "10-20" for 1/3 plot", likely in reference to sum of diameters															
88		photos show a foreground of rose, with sufficiently separated trees in the background to conclude the stem/diameter counts are accurate														
89		species	diameter	BA	assumption											
90		walnut	8	0.349066	individual											
91		buttonW	10	0.545415	individual											
92		buttonW	5	0.545415	20 inch sum of diameters recorded, guess 5 inches, 4 stems											
93		hollyoak	6	0.19635	individual											
94		willow	10	1.090831	individual											
95		willow	8	1.047198	25 inch sum of diameters recorded, guess 8 inches, 3 stems											
96		willow	4	0.698132	30 inch sum of diameters recorded for bush, guess 4 inches, 8 stems											
97		elderberry	8	0.349066	individual											
98		elderberry	3	0.147262	individual, overstory measurement says "4,3,3" so guess 3 inches, 3 stems											
99		3-4 willow	5	0.545415	20 inch sum of diameters recorded, "3-4 willows, 20' total", guess 5 inches 4 stems											
100		2 willows	5	0.409062	recorded "2 more willows, 15" total", guess 5 inches, 3 stems											
101		total BA in plot		5.923211		total per acre		8.600503								
102	plot 12: notes for this plot have a list of diameters, or diameter classes and numbers of stems, by species.															
103		species	diameter	BA	assumption											
104		willow	14	1.069014												
105		willow	13	0.921752												
106		willow	32	5.585054												
107		willow	4	0.087266												
108		willow	20	8.726646	4 of these											
109		willow	20	2.181662	1 of these											
110		willow	5	0.545415	4 of these											
111		buttonW	20	2.181662	1 of these											
112		buttonW	15	1.227185	1 of these											
113		total BA in plot		22.52566		total per acre		32.70725								
114	plot 13:	species	diameter	BA	assumption											
115		buttonW	6	0.19635	5 of these											
116		hackberry	18	1.767146												
117		willow	20	2.181662												

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
118		buttonW	6	0.785398	4 of these											
119		hackberry	9.5	0.984475	2, actually 2 stems 10 and 9"											
120		buttonW	12	1.570796	24", assume 2 12"											
121		buttonW	24	1.668971	24" assume 15 and 9"											
122		willow	45	12.27185	30 and 15"											
123		total BA in plot		21.42664		total per acre		31.11149								
124	plot 14:	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
125		buttonW	4	0.349066	4 of these											
126		buttonW	8	0.785398	3 of these, 20" total, 8" x2, 4"x1											
127		willow		0.19635	2,4, and 4"; 10" total											
128		willow	15	1.227185	individual											
129		willow	18	1.767146	individual											
130		thicket	2	0.261799	25" total dia recorded; assume 12, 2 inch stems											
131		fuzzytree	6	0.19635	individual											
132		total BA in plot		4.783293		total per acre		6.945341								
133	plot 15	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
134		species	diameter	BA	assumption											
135		corkoak	16	1.396263												
136		willow	8	0.370882	8 and 2" stems											
137		willows	1	0.1309	24x1" stems											
138		buttonW	6	0.19635												
139		willow	20	2.181662												
140		redberry	18	1.767146												
141		willows	1	0.163625	30x1" stems											
142		walnut	13	2.405282	13 and 12" stems											
143		locust	7	0.267254												
144		unid	23	2.885247												
145		total BA in plot		11.76461		total per acre		17.08221								
146	plot 16	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
147		willow	16	1.396263												
148		willow	29	4.586943	recorded "28-30" willow"; assume 29											
149		willow	30	4.908739	recorded "28-32" willow"; assume 30											
150		willow	1	1.041667	100's of 1" stems; assume 1.5" BA per stem											
151		buttonW	8	0.349066												
152		walnut	20	2.181662												
153		walnut	18	1.767146												
154		walnut	18	1.767146												
155		total BA in plot		17.99863		total per acre		26.13401								
156	plot 17	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
157		species	diameter	BA	assumption											
158		willow	30	14.72622	3, 9" stems											
159		willow	2	1.636246	thicket, assume 25, 2 inch stems											
160		willow	8	0.349066												
161		liveoak	20	2.181662												
162		willow	1	0.327249	thicket, assume 20, 1 inch stems											
163		buttonW	24	3.141593												
164		buttonW	18	0.981748	12, 6 inch stems total 18 dia											
165		total BA in plot		23.34378		total per acre		33.89517								
166	plot 18	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
167		species	diameter	BA	assumption											
168		willow	2	0.392699	thicket, 35" total , 18, 2 inch stems											
169		buttonW	14	1.069014	each stem in two bushes measured individually											
170			12	0.785398												
171			8	0.349066												
172			16	1.396263												
173		buttonW	5	0.136354												
174			3	0.049087												
175			3	0.049087												
176			3	0.049087												
177			8	0.349066												
178		valloak	25	3.408846												
179		willow	2	0.327249	thicket, 30" total , 15, 2 inch stems											
180		willow	5	0.681769	small bush, 25" dbh total, assume 5 stems 5"											
181		total BA in plot		9.042987		total per acre		13.13042								
182	plot 19	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
183		species	diameter	BA	assumption											
184		willow	5	0.818123	"large thicket"; 30", assume six, 5 inch stems											
185		willow	2	0.283616	thicket; 25", assume 13, 2 inch stems											
186		valloak	3	0.049087	individual stems on two trees measured											
187			6	0.19635												
188			4	0.087266												
189		valloak	6	0.19635	individual											
190		willow	1	0.109083	thicket; 20"; smaller stature, assume 20, 1" stems											
191			1	0.109083	thicket; 20"; smaller stature, assume 20, 1" stems											
192			1	0.109083	thicket; 20"; smaller stature, assume 20, 1" stems											
193			1	0.109083	thicket; 20"; smaller stature, assume 20, 1" stems											
194		fig	20	2.181662	individual											
195		total BA in plot		4.248786		total per acre		6.169237								

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P
196	plot 20	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
197		species	diameter	BA	assumption											
198		pecan	11	0.659953												
199		willow	18	1.767146	very large willow with many individually measured stems											
200			34	6.305002												
201			22	2.63981												
202			28	4.276057												
203			26	3.687008												
204			22	2.63981												
205		valloak	6	0.19635												
206		liveoak	6	0.19635												
207		pecan	12	0.785398												
208		willow	1	0.218166	thicket; 40"; assume 40, 1" stems											
209		willow	1	0.163625	thicket; 30"; assume 30, 1" stems											
210		total BA in plot		23.53467		total per acre		34.17235								
211	plot 21	notes - reconstructed/estimated stems from basal area and overstory dbh lists as best possible														
212		species	diameter	BA	assumption											
213		valloak	15	1.227185	individual											
214		pecan	10	0.545415	two stems, measured individually											
215			8	0.349066												
216		unid	6	1.178097	6, 6" stems											
217		corkoak	21	2.405282												
218		corkoak	11	0.659953												
219		pecan	5	0.136354												
220		unid	4	1.570796	18 stems											
221		willow	8	2.792527	large stems, 60" , estimate 8, 8" stems											
222		total BA in plot		10.86467		total per acre		31.13587								

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
1	THIS IS THE "Futures" TAB																				
2	This TAB estimates best case futures in mitigation site, that could be theoretically used to estimate mitigation ratio.																				
3	Assume a site, such as agriculture, which has no value/woody currently.																				
4																					
5	Warbler Model - Best Case Scenario										Warbler Model - Worse Case Scenario										
6	V1-shrub cover: estimate this would be optimized (60-80%) in 5 years; with lots of planting/watering										V1-shrub cover: maxes out at 40% due to water variability/dieoff after year 5										
7	V2-shrub height: estimate it would take 5 years to get to 2M tall average, with watering, ideal site										V2-shrub height: 1.2 M max due to alot of herbaceous										
8	V3-percent deciduous shrub cover: presume this would be 100%, determined by planting pallette										V3- percent deciduous shrub cover: same as best case										
9	V4-percent tall tree cover, optimized at 50-75%, is 30 feet tall, estimate 15 years										V4- percent tall tree cover, takes longer due to variable water, 40% maximum										
10																					
11		TY0	TY1	TY5	TY15	TY25	TY51					TY0	TY1	TY5	TY15	TY25	TY51				
12	V1	0	0.1	0.6	0.8	0.8	0.8				V1	0	0.1	0.6	0.5	0.5	0.5				
13	V2	0	0.1	2	2	2	2				V2	0	0.1	0.6	1.2	1.2	1.2				
14	V3	0	1	1	1	1	1				V3	0	1	1	1	1	1				
15	V4	0	0	0	0.3	0.5	0.75				V4	0	0	0	0.3	0.4	0.4				
16																					
17	SI(V1)	0.00	0.17	1.00	1.00	1.00	1.00				SI(V1)	0.00	0.17	1.00	0.83	0.83	0.83				
18	SI(V2)	0	0.05	1	1	1	1				SI(V2)	0	0.05	0.3	0.6	0.6	0.6				
19	SI(V3)	0.1	1	1	1	1	1				SI(V3)	0.1	1	1	1	1	1				
20	SI(V4)	0.5	0.5	0.5	0.8	1	1				SI(V4)	0.5	0.5	0.5	0.8	0.9	0.9				
21	HSI-ywm	0.00	0.06	0.71	0.89	1.00	1.00				HSI-ywm	0.00	0.06	0.39	0.63	0.67	0.67				
22																					
23	TY	0	1	5	15	25	51				TY	0	1	5	15	25	51				
24	HSIw/o	0.00	0.00	0.00	0.00	0.00	0.00				HSIw/o	0.00	0.00	0.00	0.00	0.00	0.00				
25	HSI w/	0.00	0.06	0.71	0.89	1.00	1.00				HSI w/	0.00	0.06	0.39	0.63	0.67	0.67				
26	area w/o	10	10	10	10	10	10				area w/o	10	10	10	10	10	10				
27	area w/	10	10	10	10	10	10				area w/	10	10	10	10	10	10				
28	HUs w/o		0	0	0	0	0				HUs w/o		0	0	0	0	0				
29	HUs w/		0.322749	15.43313	80.0767	94.72136	260				HUs w/		0.322749	9.036961	50.98769	65.1638	174.4133				
30	AAHUs without						0				AAHUs without						0				
31	AAHUs with						8.834391				AAHUs with						5.880873				
32	change due to project						8.834391				change due to project (mitigation gain)						5.880873				
33																					
34	TY	0	1	5	15	25	51														
35	HSIw/o	0.64	0.64	0.64	0.64	0.64	0.64														
36	HSI w/	0.64	0.00	0.00	0.00	0.00	0.00														
37	area w/o	13.88	13.88	13.88	13.88	13.88	13.88														
38	area w/	13.88	13.88	13.88	13.88	13.88	13.88														
39	HUs w/o		8.867974	35.4719	88.67974	88.67974	230.5673														
40	HUs w/		4.433987	0	0	0	0														
41	AAHUs without						8.867974														
42	AAHUs with						0.086941														
43	change due to project (project impact loss)						-8.78103														
44									Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres												
45	I set the area of the mitigation site at 10 acres; so this suggests the habitat value								Best case scenario: CR =			0.71611									
46	is compensated roughly at a ratio of slightly less than 1:1 with perfect mitigation								Worst case scenario: CR =			1.075757									
47																					
48					compensation area best case:			9.94													
49																					
50					compensation area worst case:			14.93151													
51																					
52	Riparian Songbird Model - best case scenario										Riparian Songbird Model - worst case scenario										

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
53	V1- % shrub cover, 1-3M;optimal 50-75%; this will take 10 years to achieve										V1 - takes 14 years, maxes out at 50%										
54	V2- % tree cover, 3+M; optimal 50-75%; takes about 15 years										V2 - takes 15 years, maxes out at 40%										
55	V3- ht of trees, optimal 6+M; takes about 10 years, with watering										V3 - takes 14 years to reach 6+M										
56	V4- layering category; 1-none, 2-low shrub, 3-tall shrubs, 4- trees only, 5- multiple layers; TY1 low only (.3); TY5-51 - multiple (1.0)													V4 - not all "5", some "2","3","4"; max SI .7							
57	V5- snags 4"+ ; optimal at 3+/ac; none for TY0-14; then optimal TY15-51										V5 - not optimal throughout; max average is 1.2 snags/ac										
58	V6- % of site as woody riparian; TY1-5%; TY5-30%; TY10-50%; TY15to51-75%										V6 - lower, max is 60%										
59																					
60	TY	0	1	5	10	14	15	51			TY	0	1	5	10	14	15	51			
61	V1	0	10	30	50	50	60	75			V1	0	10	30	40	50	50	50			
62	V2	0	0	0	30	30	50	75			V2	0	0	0	30	40	40	40			
63	V3	0	1	3	6	6	6	6			V3	0	1	3	5	6	6	6			
64	V4	1	2	3	5	5	5	5			V4	1	2	3	(assume SI of 0.7, mix of categories 2-5)						
65	V5	0	0	0	0	0	3	3			V5	0	0	0	0	0	1.2	1.2			
66	V6	0	5	30	50	75	75	75			V6	0	5	30	50	60	60	60			
67																					
68	SI(V1)	0	0	0.5	1	1	1	1			SI(V1)	0	0	0.5	0.75	1	1	1			
69	SI(V2)	0	0	0	0.5	0.5	1	1			SI(V2)	0	0	0	0.5	0.75	0.75	0.75			
70	SI(V3)	0	0	0.4	1	1	1	1			SI(V3)	0	0	0.4	0.8	1	1	1			
71	SI(V4)	0	0.3	0.5	1	1	1	1			SI(V4)	0	0.3	0.5	0.7	0.7	0.7	0.7			
72	SI(V5)	0.00	0.00	0.00	0.00	0.00	1.00	1.00			SI(V5)	0.00	0.00	0.00	0.00	0.00	0.40	0.40			
73	SI(V6)	0.00	0.00	0.26	0.47	0.74	0.74	0.74			SI(V6)	0.00	0.00	0.26	0.47	0.58	0.58	0.58			
74	HSI-rsg	0.00	0.00	0.06	0.22	0.34	0.74	0.74			HSI-rsg	0.00	0.00	0.06	0.18	0.26	0.37	0.37			
75																					
76	TY	0	1	51																	
77	HSIw/o	0.64	0.64	0.64																	
78	HSI w/	0.64	0	0.00																	
79	area w/o	13.88	13.88	13.88																	
80	area w/	13.88	13.88	13.88																	
81	HUs w/o		8.9	445.5																	
82	HUs w/		4.5	0.0																	
83	AAHUs without			8.9																	
84	AAHUs with			0.1																	
85	change due to project			-8.8																	
86																					
87	TY	0	1	5	10	14	15	51			TY	0	1	5	10	14	15	51			
88	HSIw/o	0	0	0	0	0	0	0			HSIw/o	0	0	0	0	0	0	0			
89	HSI w/	0.00	0.00	0.06	0.22	0.34	0.74	0.74			HSI w/	0.00	0.00	0.06	0.18	0.26	0.37	0.37			
90	area w/o	10	10	10	10	10	10	10			area w/o	10	10	10	10	10	10	10			
91	area w/	10	10	10	10	10	10	10			area w/	10	10	10	10	10	10	10			
92	HUs w/o		0	0	0	0	0	0			HUs w/o		0	0	0	0	0	0			
93	HUs w/		0.00	1.25	7.10	11.32	5.41	265.26			HUs w/		0.00	1.25	6.12	8.78	3.15	134.16			
94	AAHUs without							0.00			AAHUs without							0.00			
95	AAHUs with							5.69			AAHUs with							3.01			
96	change due to project							5.69			change due to project							3.01			
97																					
98	In this case it would take more than 10 acres to compensate the losses of value									Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
99	to riparian songbird guild; the estimated compensation area would be:							15.50		Best case scenario: CR =			1.11646								
100	which is somewhat more than 1:1 with perfect mitigation									Worst case scenario: CR =			2.112309								
101	with "worst case" futures; the estimated compensation area would be:							29.31885													
102																					
103	Riparian Forest Cover Type - Best Case Scenario									Riparian Forest Cover Type - Worst Case Scenario											
104																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
105	V1 - tree height; optimum 60+ feet; takes about 20 years to get this									V1 - tree height; optimum 60+ feet; max avg of 40 feet after 20 years											
106	V2 - stand width; optimum assumed if 70+ feet wide site									V2 - stand width; optimum assumed if 70+ feet wide site, same as best case											
107	V3-tree canopy closure; optimum 50-80%, may barely get there in 20 years									V3-tree canopy closure; optimum 50-80%, scenario max is 40%											
108	V4- # species; assume can be optimally planted at 4+ species, all survive									V4- # species; 3 of 4 planted species survives											
109	V5 - average understory density; optimal 30-60% this will evolve over time									V5 - average understory density; overshoots optimum after year 20											
110	TY5=20%; TY10-51 - optimal (i.e., 30-60%)									* - discount overall HSI by 1/3 per model assumes most not adjacent to water											
111																					
112	TY	0	1	5	10	15	20	51		TY	0	1	5	10	15	20	51				
113	V1	0	3	15	25	35	60	75		V1	0	3	15	25	30	40	40				
114	V2	0	70	70	70	70	70	70		V2	0	70	70	70	70	70	70				
115	V3	0	0	10	30	40	50	60		V3	0	0	10	30	35	40	40				
116	V4	0	4	4	4	4	4	4		V4	0	4	4	3	3	3	3				
117	V5	0	0	20	30	50	60	60		V5	0	0	20	25	50	70	70				
118																					
119	SI(V1)	0.00	0.05	0.25	0.42	0.58	1.00	1.00		SI(V1)	0.00	0.05	0.25	0.42	0.50	0.67	0.67				
120	SI(V2)	0.2	1	1	1	1	1	1		SI(V2)	0.2	1	1	1	1	1	1				
121	SI(V3)	0	0	0.2	0.6	0.8	1	1		SI(V3)	0	0	0.2	0.6	0.7	0.8	0.8				
122	SI(V4)	0	1	1	1	1	1	1		SI(V4)	0	1	1	1	1	1	1				
123	SI(V5)	0.20	0.20	0.73	1.00	1.00	1.00	1.00		SI(V5)	0.20	0.20	0.73	0.87	1.00	0.88	0.88				
124	HSI-rfct	0.10	0.22	0.61	0.81	0.89	1.00	1.00		HSI-rfct*	0.07	0.15	0.41	0.52	0.57	0.59	0.59				
125																					
126	TY	0	1	51																	
127	HSIw/o	0.73	0.73	0.73																	
128	HSI w/	0.73	0	0																	
129	area w/o	13.88	13.88	13.88																	
130	area w/	13.88	13.88	13.88																	
131	HUs w/o		10.1	507.4																	
132	HUs w/		5.1	0.0																	
133	AAHUs without			10.1																	
134	AAHUs with			0.1																	
135	change due to project			-10.0																	
136																					
137	TY	0	1	5	10	15	20	51		TY	0	1	5	10	15	20	51				
138	HSIw/o	0	0	0	0	0	0	0		HSIw/o	0	0	0	0	0	0	0				
139	HSI w/	0.10	0.22	0.61	0.81	0.89	1.00	1.00		HSI w/	0.07	0.15	0.41	0.52	0.57	0.59	0.59				
140	area w/o	10	10	10	10	10	10	10		area w/o	10	10	10	10	10	10	10				
141	area w/	10	10	10	10	10	10	10		area w/	10	10	10	10	10	10	10				
142	HUs w/o		0	0	0	0	0	0		HUs w/o		0	0	0	0	0	0				
143	HUs w/		1.62	16.72	35.68	42.57	47.20	310.00		HUs w/		1.08	11.20	23.33	27.35	28.90	181.36				
144	AAHUs without							0.00		AAHUs without							0.00				
145	AAHUs with							8.90		AAHUs with							5.36				
146	change due to project							8.90		change due to project							5.36				
147																					
148	In this case it would take more than 10 acres to compensate the losses of value									Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
149	to riparian forest covertype; the estimated compensation area would be:							11.29		Best case scenario: CR =			0.813662								
150	which is somewhat more than 1:1 with perfect mitigation									Worst case scenario: CR =			1.351352								
151	with "worst case" futures; the estimated compensation area would be:							18.75677													
152																					
153	Downy Woodpecker model - Best Case Scenario											Downy Woodpecker model - Worst Case Scenario									
154	V1- Basal Area, this will take awhile to maximize (44'/acre); guess is at least 20 years, remains optimal through TY51											V1 = less, slower, basal area, site heterogeneity, limits max SI to 0.7									
155	V2- 6+" snags, these take longer than 4" snags; guess 20 years for this exercise; will max out at 1.5 snags/ac											V2 = snags slightly less abundant at year 20, 1.0 snags/ac									
156																					

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
157																					
158	TY	0	1	5	10	19	20	51		TY	0	1	5	10	19	20	51				
159	V1	0	5	10	20	40	44	90		V1	0	5	10	20	24	25	31				
160	V2	0	0	0	0	0	1.5	1.5		V2	0	0	0	0	0	1	1				
161																					
162	SI(V1)	0.00	0.11	0.23	0.45	0.91	1.00	0.97		SI(V1)	0.00	0.11	0.23	0.45	0.55	0.57	0.70				
163	SI(V2)	0.00	0.00	0.00	0.00	0.00	0.30	0.30		SI(V2)	0.00	0.00	0.00	0.00	0.00	0.20	0.20				
164	HSI-dw	0.00	0.00	0.00	0.00	0.00	0.30	0.30		HSI-dw	0.00	0.00	0.00	0.00	0.00	0.20	0.20				
165																					
166	TY	0	1	51																	
167	HSIw/o	0.23	0.23	0.23																	
168	HSI w/	0.23	0	0.00																	
169	area w/o	13.88	13.88	13.88																	
170	area w/	13.88	13.88	13.88																	
171	HUs w/o		3.2	160.5																	
172	HUs w/		1.6	0.0																	
173	AAHUs without			3.2																	
174	AAHUs with			0.0																	
175	change due to project			-3.2																	
176																					
177	TY	0	1	5	10	14	15	51		TY	0	1	5	10	14	15	51				
178	HSIw/o	0	0	0	0	0	0	0		HSIw/o	0	0	0	0	0	0	0				
179	HSI w/	0.00	0.00	0.00	0.00	0.00	0.30	0.30		HSI w/	0.00	0.00	0.00	0.00	0.00	0.20	0.20				
180	area w/o	10	10	10	10	10	10	10		area w/o	10	10	10	10	10	10	10				
181	area w/	10	10	10	10	10	10	10		area w/	10	10	10	10	10	10	10				
182	HUs w/o		0	0	0	0	0	0		HUs w/o		0	0	0	0	0	0				
183	HUs w/		0.00	0.00	0.00	0.00	1.50	108.00		HUs w/		0.00	0.00	0.00	0.00	1.00	72.00				
184	AAHUs without							0.00		AAHUs without							0.00				
185	AAHUs with							2.15		AAHUs with							1.43				
186	change due to project							2.15		change due to project							1.43				
187																					
188	Best case it would take more than 10 acres to compensate the losses of value									Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
189	to downy woodpecker; the estimated compensation area would be:							14.81		Best case scenario: CR =			1.066869								
190	which is more than 1:1 with perfect mitigation									Worst case scenario: CR =			1.600304								
191	Note: this assumes higher snag density (1.5/ac) than seen natural (1.08)									Note: lower overall snag densities possible where easements restrict woody plantings/height											
192	which could occur if larger trees were set as goal; may be unrealistic																				
193	with "worst case" futures; the estimated compensation area would be:							22.21222													
194																					
195	Hairy Woodpecker - best case scenario											Hairy Woodpecker - worst case scenario (shrub emphasis, encroachments, cover/dbh more limited)									
196	V1 - snags >10"; optimum at 2+/acre; begin to form at year 20											V1 - snags >10"; optimum at 1/acre; begin to form at year 30									
197	V2 - mean dbh, nesting, has value at 8+ inches (year 15), opt at 15+" (year 25)											V2 - mean dbh, nesting, has value at 8+ inches (year 15), opt at 10+" due to encroachment limits (year 20)									
198	V3 - mean dbh, cover, min value SI .5, then increases with dbh 6 to 12" (years 10 to 20); max 15 (year 25+)											V3 - mean dbh, cover, min value SI .5, then increases with dbh 6 to 10" (years 10 to 20)									
199	V4 - % canopy cover, begins to have value >15%,then increases with cover to 55% (years 5 to 25), max 60% (yr 51)											V4 - % canopy cover, begins to have value >15%,then increases with cover to 40% (years 5 to 25)									
200																					
201	TY	0	1	5	10	15	19	20	25	51		TY	0	1	5	10	15	25	29	30	51
202	V1	0	0	0	0	0	0	1	2	2		V1	0	0	0	0	0	0	0	1	1
203	V2	0	1	3	6	8	9	12	15	15		V2	0	1	3	6	8	9	10	10	10
204	V3	0	1	3	6	8	9	12	15	15		V3	0	1	3	6	8	9	10	10	10
205	V4	0	0	0	30	40	48	50	55	60		V4	0	0	0	30	35	40	40	40	40
206																					
207	SI(V1)	0	0	0	0	0	0	0.2	0.4	0.4		SI(V1)	0	0	0	0	0	0	0	0.2	0.2
208	SI(V2)	0.00	0.00	0.00	0.00	0.00	0.14	0.57	1.00	1.00		SI(V2)	0.00	0.00	0.00	0.00	0.00	0.14	0.29	0.29	0.29

	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U
209	SI(V3)	0.50	0.50	0.50	0.51	0.77	0.89	1.00	1.00	1.00		SI(V3)	0.50	0.50	0.50	0.51	0.77	0.89	1.00	1.00	1.00
210	SI(V4)	0.00	0.00	0.00	0.21	0.36	0.47	0.50	0.57	0.64		SI(V4)	0.00	0.00	0.00	0.21	0.29	0.36	0.36	0.36	0.36
211	HSI(hw)	0.00	0.00	0.00	0.00	0.00	0.05	0.32	0.66	0.74		HSI(hw)	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.15	0.15
212																					
213	TY	0	1	51																	
214	HSIw/o	0.06	0.06	0.06																	
215	HSI w/	0.06	0	0																	
216	area w/o	13.88	13.88	13.88																	
217	area w/	13.88	13.88	13.88																	
218	HUs w/o		0.9	43.6																	
219	HUs w/		0.4	0.0																	
220	AAHUs without			0.9																	
221	AAHUs with			0.0																	
222	change due to project			-0.9																	
223																					
224	TY	0	1	5	10	15	19	20	25	51		TY	0	1	5	10	15	29	30	25	51
225	HSIw/o	0	0	0		0	0	0	0	0		HSIw/o	0	0	0	0	0	0	0	0	0
226	HSI w/	0.00	0.00	0.00	0.00	0.00	0.05	0.32	0.66	0.74		HSI w/	0.00	0.00	0.00	0.00	0.00	0.03	0.08	0.15	0.15
227	area w/o	10	10	10	10	10	10	10	10	10		area w/o	10	10	10	10	10	10	10	10	10
228	area w/	10	10	10	10	10	10	10	10	10		area w/	10	10	10	10	10	10	10	10	10
229	HUs w/o		0	0	0	0	0	0	0	0		HUs w/o		0	0	0	0	0	0	0	0
230	HUs w/		0.00	0.00	0.00	0.00	0.91	1.80	24.32	181.54		HUs w/		0.00	0.00	0.00	0.00	2.41	0.56	-5.63	38.58
231	AAHUs without									0.00		AAHUs without									0.00
232	AAHUs with									4.09		AAHUs with									0.70
233	change due to project									4.09		change due to project									0.70
234																					
235	Best case it would take far less than 10 acres to compensate the losses of value											Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres									
236	to hairy woodpecker; the estimated compensation area would be:							2.11				Best case scenario: CR =		0.152019							
237	which is less than 1:1 with perfect mitigation											Worst case scenario: CR =		0.882875							
238	Note: this assumes higher snag density (1.5/ac) than seen natural (1.08)											Note: lower overall snag densities possible where easements restrict woody plantings/height									
239	which could occur if larger trees were set as goal; may be unrealistic											Also less than 1:1 with lower futures, although HSI (0.15 after yr 25) much better than baseline (0.06)									
240	With "worst case" futures; the estimated compensation area would be:							12.2543													
241																					
242	Summary Table of Futures-based compensation area and ratio for best/worse case scenarios																				
243					mitigation need		mitigation ratio														
244	scenario		best	worst	best	worst	best	worse													
245		project	mitigation	mitigation																	
246		loss	gain, 10ac	gain, 10ac																	
247	MODEL	AAHUs	AAHUs	AAHUs																	
248	mWarblr	-8.8	8.8	5.9	9.9	14.9	0.72	1.08													
249	RSG	-8.8	5.7	3.0	15.5	29.3	1.12	2.11													
250	RFCT	-10.0	8.9	5.4	11.3	18.8	0.81	1.35													
251	DW	-3.2	2.1	1.4	14.8	22.2	1.07	1.60													
252	HW	-0.9	4.1	0.7	2.1	12.3	0.15	0.88													

	A	B	C	D	E	F	G	H	I	J	K	L
1	THIS IS THE "FuturesExcess" TAB											
2	In this TAB: a simplified future test is done, in which the starting point of the mitigation site is advanced by 10 years											
3	This scenario informs how excess mitigation might apply to a future project phase, or if mitigation is started before impact.											
4	For the purpose of this exercise, it is assumed the impact site is similar to TS_30_L in baseline value and impact											
5	The 10 year advance is done by creating a TY0 and 1 which has the same as the TY10 (or next higher TY) in the "Futures" Tab.											
6	NOTE:	ONLY using the worse case scenario for mitigation sites, however, in this future test										
7												
8	10 YEAR HEADSTART WORST CASE SHOWN BELOW											
9	NOTE: proofed 10/31/22											
10	THESE ARE THE RELEVANT COLUMNS											
11	TO SHOW VALUE OF MITIGATION "LEFT OVER" OR STARTED EARLY.											
12												
13	WARBLER MODEL											
14	Warbler Model - Worse Case Scenario											
15	V1-shrub cover: maxes out at 40% due to water variability/dieoff after year 5											
16	V2-shrub height: 1.2 M max due to alot of herbaceous											
17	V3- percent deciduous shrub cover: same as best case											
18	V4- percent tall tree cover, takes longer due to variable water, 40% maximum											
19												
20		TY0	TY1	TY5	TY15	TY25	TY51					
21	V1	0.5	0.5	0.5	0.5	0.5	0.5					
22	V2	1.2	1.2	1.2	1.2	1.2	1.2					
23	V3	1	1	1	1	1	1					
24	V4	0.3	0.4	0.4	0.4	0.4	0.4					
25												
26	SI(V1)	0.83	0.83	0.83	0.83	0.83	0.83					
27	SI(V2)	0.6	0.6	0.6	0.6	0.6	0.6					
28	SI(V3)	1	1	1	1	1	1					
29	SI(V4)	0.8	0.9	0.9	0.9	0.9	0.9					
30	HSI-ywm	0.63	0.67	0.67	0.67	0.67	0.67					
31												
32	TY	0	1	5	15	25	51					
33	HSIw/o	0.00	0.00	0.00	0.00	0.00	0.00					
34	HSI w/	0.63	0.67	0.67	0.67	0.67	0.67					
35	area w/o	10	10	10	10	10	10					
36	area w/	10	10	10	10	10	10					
37	HUs w/o		0	0	0	0	0					
38	HUs w/		6.51638	26.83282	67.08204	67.08204	174.4133					
39	AAHUs without						0					
40	AAHUs with						6.704443					
41	change due to project (mitigation gain)						6.704443					
42												
43	TY	0	1	5	15	25	51					
44	HSIw/o	0.64	0.64	0.64	0.64	0.64	0.64					
45	HSI w/	0.64	0.00	0.00	0.00	0.00	0.00					
46	area w/o	13.88	13.88	13.88	13.88	13.88	13.88					
47	area w/	13.88	13.88	13.88	13.88	13.88	13.88					
48	HUs w/o		8.867974	35.4719	88.67974	88.67974	230.5673					
49	HUs w/		4.433987	0	0	0	0					
50	AAHUs without						8.867974					
51	AAHUs with						0.086941					
52	change due to project (project impact loss)						-8.78103					
53	Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
54												
55	worst case scenario, future with mitigation started 10 years prior to impact: CR =									**0.943612**		
56	Compare with worst case scenario, future with mitigation started same time of impact: CR=									1.075757		
57												

	A	B	C	D	E	F	G	H	I	J	K	L
58	compensation area worst case, mitigation started 10 yrs before impact:							13.09733				
59	compensation area worst case, mitigation started same time as impact:							14.93151				
60												
61	RIPARIAN SONGBIRD MODEL											
62	Riparian Songbird Model - worst case scenario											
63	V1 - takes 14 years, maxes out at 50%											
64	V2 - takes 15 years, maxes out at 40%											
65	V3 - takes 14 years to reach 6+M											
66				V4 - not all "5", some "2","3","4"; max SI .7								
67	V5 - not optimal throughout; max average is 1.2 snags/ac											
68	V6 - lower, max is 60%											
69												
70	TY	10	10	10	10	14	15	51				
71	V1	40	40	40	40	50	50	50				
72	V2	30	30	30	30	40	40	40				
73	V3	5	5	5	5	6	6	6				
74	V4	3	3	3	(assume SI of 0.7, mix of categories 2-5)							
75	V5	0	0	0	0	0	1.2	1.2				
76	V6	30	30	30	50	60	60	60				
77												
78	SI(V1)	0.75	0.75	0.75	0.75	1	1	1				
79	SI(V2)	0.5	0.5	0.5	0.5	0.75	0.75	0.75				
80	SI(V3)	0.8	0.8	0.8	0.8	1	1	1				
81	SI(V4)	0.7	0.7	0.7	0.7	0.7	0.7	0.7				
82	SI(V5)	0.00	0.00	0.00	0.00	0.00	0.40	0.40				
83	SI(V6)	0.26	0.26	0.26	0.47	0.58	0.58	0.58				
84	HSI-rsg	0.10	0.10	0.10	0.18	0.26	0.37	0.37				
85												
86	TY	0	1	51								
87	HSIw/o	0.64	0.64	0.64								
88	HSI w/	0.64	0	0.00								
89	area w/o	13.88	13.88	13.88								
90	area w/	13.88	13.88	13.88								
91	HUs w/o		8.9	445.5								
92	HUs w/		4.5	0.0								
93	AAHUs without			8.9								
94	AAHUs with			0.1								
95	change due to project			-8.8								
96												
97	TY	0	1	5	10	14	15	51				
98	HSIw/o	0	0	0	0	0	0	0				
99	HSI w/	0.10	0.10	0.10	0.18	0.26	0.37	0.37				
100	area w/o	10	10	10	10	10	10	10				
101	area w/	10	10	10	10	10	10	10				
102	HUs w/o		0	0	0	0	0	0				
103	HUs w/		1.01	4.05	7.09	8.78	3.15	134.16				
104	AAHUs without							0.00				
105	AAHUs with							3.10				
106	change due to project							3.10				
107												
108	Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
109												
110		worst case scenario, future with mitigation started 10 years prior to impact: CR =								**2.048404**		
111	Compare with worst case scenario, future with mitigation started same time of impact: CR=									**2.112309**		
112												
113	compensation area worst case, mitigation started 10 yrs before impact:							28.43185				
114	compensation area worst case, mitigation started same time as impact:							29.31885				

	A	B	C	D	E	F	G	H	I	J	K	L
115	Note: slightly lower than mitigation concurrent, 10 yr headstart makes little difference											
116												
117	RIPARIAN FOREST COVER TYPE MODEL											
118	Riparian Forest Cover Type - Worst Case Scenario											
119												
120	V1 - tree height; optimum 60+ feet; max avg of 40 feet after 20 years											
121	V2 - stand width; optimum assumed if 70+ feet wide site, same as best case											
122	V3-tree canopy closure; optimum 50-80%, scenario max is 40%											
123	V4- # species; 3 of 4 planted species survives											
124	V5 - average understory density; overshoots optimum after year 20											
125	* - discount overall HSI by 1/3 per model assumes most not adjacent to water											
126												
127	TY	0	1	5	10	15	20	51				
128	V1	25	25	25	25	30	40	40				
129	V2	70	70	70	70	70	70	70				
130	V3	30	30	30	30	35	40	40				
131	V4	3	3	3	3	3	3	3				
132	V5	25	25	25	25	50	70	70				
133												
134	SI(V1)	0.42	0.42	0.42	0.42	0.50	0.67	0.67				
135	SI(V2)	1	1	1	1	1	1	1				
136	SI(V3)	0.6	0.6	0.6	0.6	0.7	0.8	0.8				
137	SI(V4)	0	1	1	1	1	1	1				
138	SI(V5)	0.87	0.87	0.87	0.87	1.00	0.88	0.88				
139	HSI-rfct*	0.31	0.52	0.52	0.52	0.57	0.59	0.59				
140												
141	TY	0	1	51								
142	HSIw/o	0.73	0.73	0.73								
143	HSI w/	0.73	0	0								
144	area w/o	13.88	13.88	13.88								
145	area w/	13.88	13.88	13.88								
146	HUs w/o		10.1	507.4								
147	HUs w/		5.1	0.0								
148	AAHUs without			10.1								
149	AAHUs with			0.1								
150	change due to project			-10.0								
151												
152	TY	0	1	5	10	15	20	51				
153	HSIw/o	0	0	0	0	0	0	0				
154	HSI w/	0.31	0.52	0.52	0.52	0.57	0.59	0.59				
155	area w/o	10	10	10	10	10	10	10				
156	area w/	10	10	10	10	10	10	10				
157	HUs w/o		0	0	0	0	0	0				
158	HUs w/		4.17	20.92	26.15	27.35	28.90	181.36				
159	AAHUs without							0.00				
160	AAHUs with							5.66				
161	change due to project							5.66				
162												
163	Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
164												
165		worst case scenario, future with mitigation started 10 years prior to impact: CR =								**1.278279**		
166	Compare with worst case scenario, future with mitigation started same time of impact: CR=									**1.351352**		
167	compensation area worst case, mitigation started 10 yrs before impact:							17.74252				
168	compensation area worst case, mitigation started same time as impact:							18.75677				
169	Note: Again, a 10 year headstart on mitigation slightly lowers worst case CR											
170												
171	DOWNY WOODPECKER MODEL											

	A	B	C	D	E	F	G	H	I	J	K	L
172			Downy Woodpecker model - Worst Case Scenario									
173			V1 = less, slower, basal area, site heterogeneity, limits max SI to 0.7									
174			V2 = snags slightly less abundant at year 10, 1.0 snags/ac									
175												
176	Note: for the 10 year headstart, shifted TY10 to TY0, and TY20 to TY10 and higher											
177	TY	0	1	5	9	10	20	51				
178	V1	0	20	20	24	25	25	31				
179	V2	0	0	0	0	1	1	1				
180												
181	SI(V1)	0.00	0.45	0.45	0.55	0.57	0.57	0.70				
182	SI(V2)	0.00	0.00	0.00	0.00	0.20	0.20	0.20				
183	HSI-dw	0.00	0.00	0.00	0.00	0.20	0.20	0.20				
184												
185	TY	0	1	51								
186	HSIw/o	0.23	0.23	0.23								
187	HSI w/	0.23	0	0.00								
188	area w/o	13.88	13.88	13.88								
189	area w/	13.88	13.88	13.88								
190	HUs w/o		3.2	160.5								
191	HUs w/		1.6	0.0								
192	AAHUs without			3.2								
193	AAHUs with			0.0								
194	change due to project			-3.2								
195												
196	TY	0	1	5	10	14	15	51				
197	HSIw/o	0	0	0	0	0	0	0				
198	HSI w/	0.00	0.00	0.00	0.00	0.20	0.20	0.20				
199	area w/o	10	10	10	10	10	10	10				
200	area w/	10	10	10	10	10	10	10				
201	HUs w/o		0	0	0	0	0	0				
202	HUs w/		0.00	0.00	0.00	4.00	2.00	72.00				
203	AAHUs without							0.00				
204	AAHUs with							1.53				
205	change due to project							1.53				
206												
207	Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
208												
209		worst case scenario, future with mitigation started 10 years prior to impact: CR =								**1.49772**		
210	Compare with worst case scenario, future with mitigation started same time of impact: CR=									**1.600304**		
211	Note: lower overall snag densities possible where easements restrict woody plantings/height											
212	Note: again, slightly lower CR with 10 year headstart on mitigation site											
213	compensation area worst case, mitigation started 10 yrs before impact:							20.78836				
214	compensation area worst case, mitigation started same time as impact:							22.21222				
215												
216	HAIRY WOODPECKER MODEL											
217	Hairy Woodpecker - worst case scenario (shrub emphasis, encroachments, cover/dbh more limited)											
218	V1 - snags >10"; optimum at 1/acre; begin to form at year 20											
219	V2 - mean dbh, nesting, has value at 8+ inches (year 5), opt at 10+" due to encroachment limits (year 10)											
220	V3 - mean dbh, cover, min value SI .5, then increases with dbh 6 to 10" (years 0 to 10)											
221	V4 - % canopy cover, begins to have value >15%,then increases with cover to 40% (years 0 to 15)											
222												
223	TY	0	1	5	10	15	19	20	25	51		
224	V1	0	0	0	1	1	1	1	1	1		
225	V2	0	1	8	10	10	10	10	10	10		
226	V3	6	6	8	10	10	10	10	10	10		
227	V4	30	30	35	40	40	40	40	40	40		
228												

	A	B	C	D	E	F	G	H	I	J	K	L
229	SI(V1)	0	0	0	0.2	0.2	0.2	0.2	0.2	0.2		
230	SI(V2)	0.00	0.00	0.00	0.29	0.29	0.29	0.29	0.29	0.29		
231	SI(V3)	0.51	0.51	0.77	1.00	1.00	1.00	1.00	1.00	1.00		
232	SI(V4)	0.21	0.21	0.29	0.36	0.36	0.36	0.36	0.36	0.36		
233	HSI(hw)	0.00	0.00	0.00	0.15	0.15	0.15	0.15	0.15	0.15		
234												
235	TY	0	1	51								
236	HSIw/o	0.06	0.06	0.06								
237	HSI w/	0.06	0	0								
238	area w/o	13.88	13.88	13.88								
239	area w/	13.88	13.88	13.88								
240	HUs w/o		0.9	43.6								
241	HUs w/		0.4	0.0								
242	AAHUs without			0.9								
243	AAHUs with			0.0								
244	change due to project			-0.9								
245												
246	TY	0	1	5	10	15	19	20	25	51		
247	HSIw/o	0	0	0	0	0	0	0	0	0		
248	HSI w/	0.00	0.00	0.00	0.15	0.15	0.15	0.15	0.15	0.15		
249	area w/o	10	10	10	10	10	10	10	10	10		
250	area w/	10	10	10	10	10	10	10	10	10		
251	HUs w/o		0	0	0	0	0	0	0	0		
252	HUs w/		0.00	0.00	3.71	7.42	5.94	1.48	7.42	38.58		
253	AAHUs without									0.00		
254	AAHUs with									1.27		
255	change due to project									1.27		
256												
257	Compensation Ratio estimate: CR = loss at impact site/gain at mitigation site X 10/13.88 acres											
258												
259		worst case scenario, future with mitigation started 10 years prior to impact: CR =								**0.49115**		
260	Compare with worst case scenario, future with mitigation started same time of impact: CR=									**0.882875**		
261	Note: lower overall snag densities possible where easements restrict woody plantings/height											
262	Also less than 1:1 with lower futures, although HSI (0.15 after yr 19) much better than baseline (0.06)											
263	compensation area worst case, mitigation started 10 yrs before impact:							6.817155				
264	compensation area worst case, mitigation started same time as impact:							12.2543				
265	NOTE: Above boldface value shows significant reduction compared to without 10 years											
266												
267	Summary Table of Futures-based compensation area and ratio for worst case scenario, 10 year advance mitigation											
268				hab value		comp		mitigation ratios				
269				10 yr adv		area		this TAB	from prior TAB			
270	scenario			worst		worst		worst	mitigation starts same			
271		project		mitigation		10 yr adv		10y adv	year as impact			
272		loss		gain, 10ac								
273	MODEL	AAHUs		AAHUs				COMPARE THESE				
274	mWarblr	-8.8		**6.7**		**13.1**		**0.94**	1.08			
275	RSG	-8.8		**3.1**		**28.4**		**2.05**	2.11			
276	RFCT	-10.0		**5.7**		**17.7**		**1.28**	1.35			
277	DW	-3.2		**1.5**		**20.8**		**1.50**	1.60			
278	HW	-0.9		**1.3**		**6.8**		**0.49**	0.88			
279												
280	Note: in the columns A-H, above left, the boldfaced values show the effect of the 10 year headstart											
281	If mitigation area were "left over" from a larger than needed site for TS_30_L, the compensation											
282	for a next reach exactly the same as TS_30_L, would be slightly less, due to greater AAHUs											
283	gained per 10 acres of mitigation site, which would be 10 years ahead and of higher value											
284	It isn't a huge difference, however, and the highest ratio of all models still rounds to 2:1											

APPENDIX B: Models

Biological Services Program
and
Division of Ecological Services

FWS/OBS-82/10.27
JULY 1982

HABITAT SUITABILITY INDEX MODELS: YELLOW WARBLER

Fish and Wildlife Service

U.S. Department of the Interior

The Biological Services Program was established within the U.S. Fish and Wildlife Service to supply scientific information and methodologies on key environmental issues that impact fish and wildlife resources and their supporting ecosystems. The mission of the program is as follows:

- To strengthen the Fish and Wildlife Service in its role as a primary source of information on national fish and wildlife resources, particularly in respect to environmental impact assessment.

- To gather, analyze, and present information that will aid decisionmakers in the identification and resolution of problems associated with major changes in land and water use.

- To provide better ecological information and evaluation for Department of the Interior development programs, such as those relating to energy development.

Information developed by the Biological Services Program is intended for use in the planning and decisionmaking process to prevent or minimize the impact of development on fish and wildlife. Research activities and technical assistance services are based on an analysis of the issues, a determination of the decisionmakers involved and their information needs, and an evaluation of the state of the art to identify information gaps and to determine priorities. This is a strategy that will ensure that the products produced and disseminated are timely and useful.

Projects have been initiated in the following areas: coal extraction and conversion; power plants; geothermal, mineral and oil shale development; water resource analysis, including stream alterations and western water allocation; coastal ecosystems and Outer Continental Shelf development; and systems inventory, including National Wetland Inventory, habitat classification and analysis, and information transfer.

The Biological Services Program consists of the Office of Biological Services in Washington, D.C., which is responsible for overall planning and management; National Teams, which provide the Program's central scientific and technical expertise and arrange for contracting biological services studies with states, universities, consulting firms, and others; Regional Staffs, who provide a link to problems at the operating level; and staffs at certain Fish and Wildlife Service research facilities, who conduct in-house research studies.

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

FWS/OBS-82/10.27
July 1982

HABITAT SUITABILITY INDEX MODELS: YELLOW WARBLER

by

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PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

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CONTENTS

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YELLOW WARBLER (*Dendroica petechia*)

HABITAT USE INFORMATION

General

The yellow warbler (*Dendroica petechia*) is a breeding bird throughout the entire United States, with the exception of parts of the Southeast (Robbins et al. 1966). Preferred habitats are wet areas with abundant shrubs or small trees (Bent 1953). Yellow warblers inhabit hedgerows, thickets, marshes, swamp edges (Starling 1978), aspen (*Populus* spp.) groves, and willow (*Salix* spp.) swamps (Salt 1957), as well as residential areas (Morse 1966).

Food

More than 90% of the food of yellow warblers is insects (Bent 1953), taken in proportion to their availability (Busby and Sealy 1979). Foraging in Maine occurred primarily on small limbs in deciduous foliage (Morse 1973).

Water

Dietary water requirements were not mentioned in the literature. Yellow warblers prefer wet habitats (Bent 1953; Morse 1966; Stauffer and Best 1980).

Cover

Cover needs of the yellow warbler are assumed to be the same as reproduction habitat needs and are discussed in the following section.

Reproduction

Preferred foraging and nesting habitats in the Northeast are wet areas, partially covered by willows and alders (*Alnus* spp.), ranging in height from 1.5 to 4 m (5 to 13.3 ft) (Morse 1966). It is unusual to find yellow warblers in extensive forests (Hebard 1961) with closed canopies (Morse 1966). Yellow warblers in small islands of mixed coniferous-deciduous growth in Maine utilized deciduous foliage far more frequently than would be expected by chance alone (Morse 1973). Coniferous areas were mostly avoided and areas of low deciduous growth preferred.

Nests are generally placed 0.9 to 2.4 m (3 to 8 ft) above the ground, and nest heights rarely exceed 9.1 to 12.2 m (30 to 40 ft) (Bent 1953). Plants used for nesting include willows, alders, and other hydrophytic shrubs and trees (Bent 1953), including box-elders (Acer negundo) and cottonwoods (Populus spp.) (Schrantz 1943). In Iowa, dense thickets were frequently occupied by yellow warblers while open thickets with widely spaced shrubs rarely contained nests (Kendeigh 1941).

Males frequently sing from exposed song perches (Kendeigh 1941; Ficken and Ficken 1965), although yellow warblers will nest in areas without elevated perches (Morse 1966).

A number of Breeding Bird Census reports (Van Velzen 1981) were summarized to determine nesting habitat needs of the yellow warbler, and a clear pattern of habitat preferences emerged. Yellow warblers nested in less than 5% of census areas comprised of extensive upland forested cover types (deciduous or coniferous) across the entire country. Approximately two-thirds of all census areas with deciduous shrub-dominated cover types were utilized, while shrub wetland types received 100% use. Wetlands dominated by shrubs had the highest average breeding densities of all cover types [2.04 males per ha (2.5 acre)]. Approximately two-thirds of the census areas comprised of forested draws and riparian forests of the western United States were used, but average densities were low [0.5 males per ha (2.5 acre)].

Interspersion

Yellow warblers in Iowa have been reported to prefer edge habitats (Kendeigh 1941; Stauffer and Best 1980). Territory size has been reported as 0.16 ha (0.4 acre) (Kendeigh 1941) and 0.15 ha (0.37 acre) (Kammeraad 1964).

Special Considerations

The yellow warbler has been on the Audubon Society's Blue List of declining birds for 9 of the last 10 years (Tate 1981).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model has been developed for application within the breeding range of the yellow warbler.

Season. This model was developed to evaluate the breeding season habitat needs of the yellow warbler.

Cover types. This model was developed to evaluate habitat in the dominant cover types used by the yellow warbler: Deciduous Shrubland (DS) and Deciduous Scrub/Shrub Wetland (DSW) (terminology follows that of U.S. Fish and Wildlife Service 1981). Yellow warblers only occasionally utilize forested habitats and reported population densities in forests are low. The habitat requirements in forested habitats are not well documented in the literature. For these reasons, this model does not consider forested cover types.

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before an area will be occupied by a species. Information on the minimum habitat area for the yellow warbler was not located in the literature. Based on reported territory sizes, it is assumed that at least 0.15 ha (0.37 acre) of suitable habitat must be available for the yellow warbler to occupy an area. If less than this amount is present, the HSI is assumed to be 0.0.

Verification level. Previous drafts of the yellow warbler habitat model were reviewed by Douglass H. Morse and specific comments were incorporated into the current model (Morse, pers. comm.).

Model Description

Overview. This model considers the quality of the reproduction (nesting) habitat needs of the yellow warbler to determine overall habitat suitability. Food, cover, and water requirements are assumed to be met by nesting needs.

The relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler is illustrated in Figure 1.

Habitat variable	Life requisite	Cover types	
Percent deciduous shrub crown cover Average height of deciduous shrub canopy Percent of shrub canopy comprised of hydrophytic shrubs	→ Reproduction	→ Deciduous Shrubland Deciduous Scrub/ Shrub Wetland	→ HSI

Figure 1. Relationship between habitat variables, life requisites, cover types, and the HSI for the yellow warbler.

The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the yellow warbler and to explain and justify the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables that will be used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

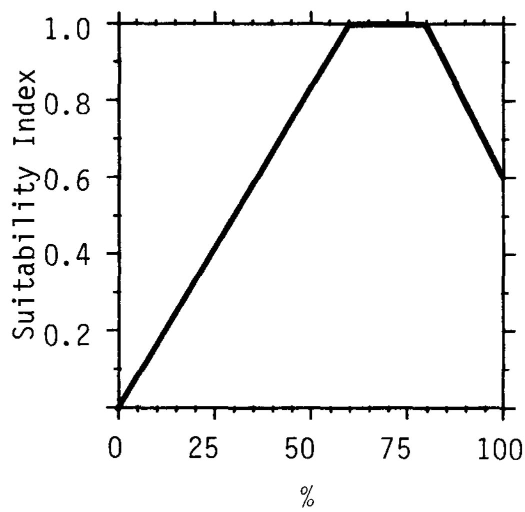
Reproduction component. Optimal nesting habitat for the yellow warbler is provided in wet areas with dense, moderately tall stands of hydrophytic deciduous shrubs. Upland shrub habitats on dry sites will provide only marginal suitability.

It is assumed that optimal habitats contain 100% hydrophytic deciduous shrubs and that habitats with no hydrophytic shrubs will provide marginal suitability. Shrub densities between 60 and 80% crown cover are assumed to be optimal. As shrub densities approach zero cover, suitability also approaches zero. Totally closed shrub canopies are assumed to be of only moderate suitability, due to the probable restrictions on movement of the warblers in those conditions. Shrub heights of 2 m (6.6 ft) or greater are assumed to be optimal, and suitability will decrease as heights decrease to zero.

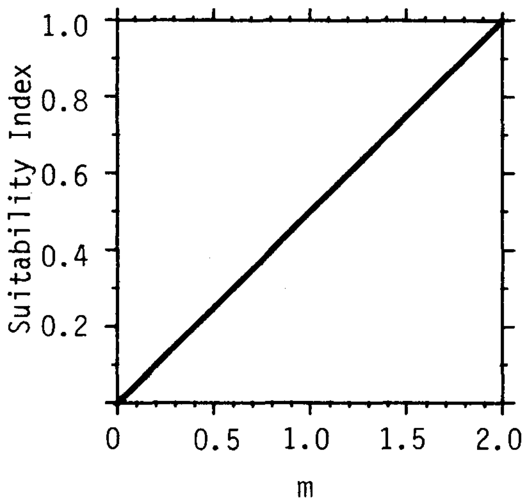
Each of these habitat variables exert a major influence in determining overall habitat quality for the yellow warbler. A habitat must contain optimal levels of all variables to have maximum suitability. Low values of any one variable may be partially offset by higher values of the remaining variables. Habitats with low values for two or more variables will provide low overall suitability levels.

Model Relationships

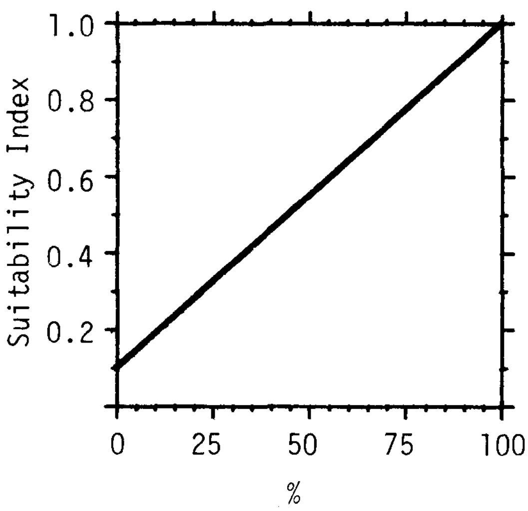
Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		
DS,DSW	V_1	Percent deciduous shrub crown cover.	

DS,DSW V_2 Average height of deciduous shrub canopy.



DS,DSW V_3 Percent of deciduous shrub canopy comprised of hydrophytic shrubs.



Equations. In order to obtain life requisite values for the yellow warbler, the SI values for appropriate variables must be combined with the use of equations. A discussion and explanation of the assumed relationship between variables was included under Model Description, and the specific equation in this model was chosen to mimic these perceived biological relationships as closely as possible. The suggested equation for obtaining a reproduction value is presented below.

Life requisite	Cover type	Equation
Reproduction	DS,DSW	$(V_1 \times V_2 \times V_3)^{1/2}$

HSI determination. The HSI value for the yellow warbler is equal to the reproduction value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (definition)		Cover types	Suggested technique
V_1	Percent deciduous shrub crown cover (the percent of the ground that is shaded by a vertical projection of the canopies of woody deciduous vegetation which are less than 5 m (16.5 ft) in height).	DS,DSW	Line intercept
V_2	Average height of deciduous shrub canopy (the average height from the ground surface to the top of those shrubs which comprise the uppermost shrub canopy).	DW,DSW	Graduated rod
V_3	Percent of deciduous shrub canopy comprised of hydrophytic shrubs (the relative percent of the amount of hydrophytic shrubs compared to all shrubs, based on canopy cover).	DS,DSW	Line intercept

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

No other habitat models for the yellow warbler were located.

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16. Abstract (Limit: 200 words)

Habitat preferences of the yellow warbler (Dendroica petechia) are described in this publication. It is one of a series of Habitat Suitability Index (HSI) models and was developed through an analysis of available information on the species-habitat requirements of the species. Habitat use information is presented in a review of the literature, followed by the development of an HSI model, designed for use in impact assessment and habitat management activities.

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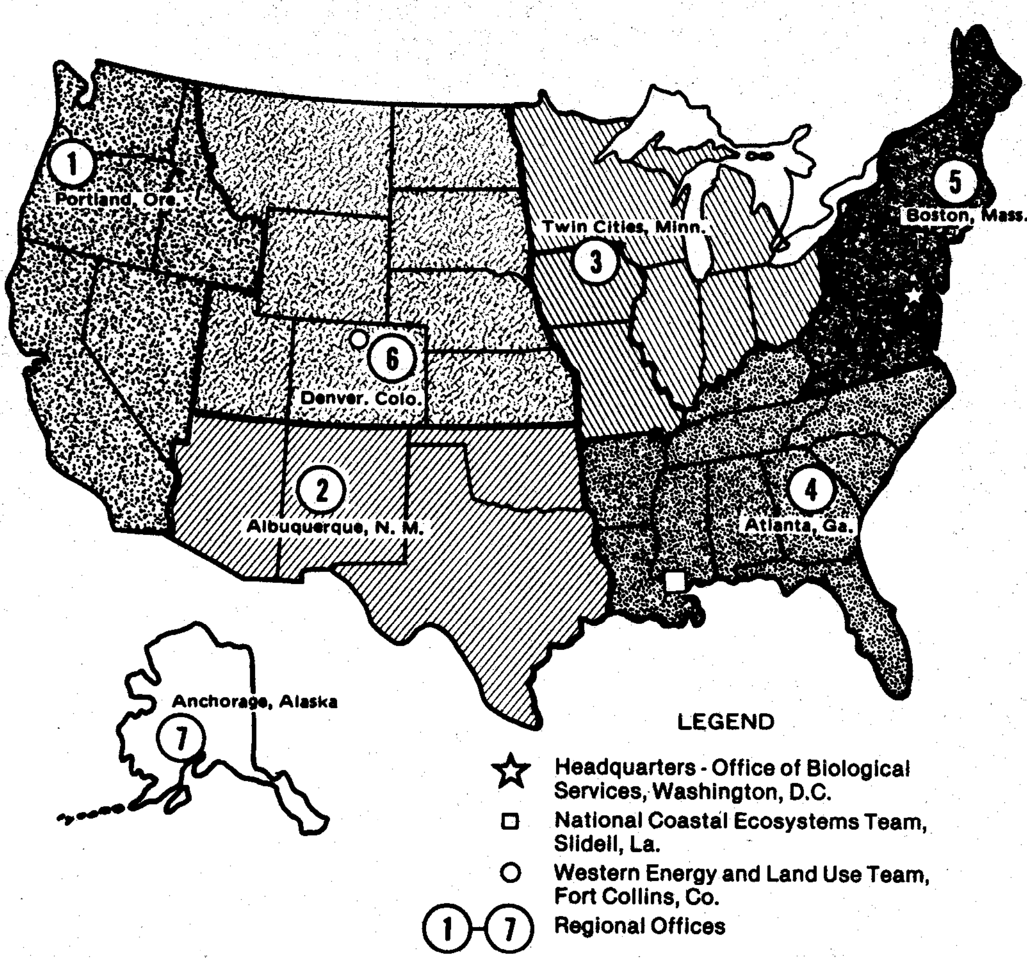

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HABITAT SUITABILITY INDEX MODEL

RIPARIAN SONGBIRD GUILD

HUMBOLDT BAY, CALIFORNIA

Prepared for:

California State Coastal Conservancy
County of Humboldt, Department of Public Works
Humboldt Bay Working Group

Prepared by:

R. Chad Roberts, Ph.D.
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August 1986

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HABITAT SUITABILITY INDEX MODEL

RIPARIAN SONGBIRD GUILD

HUMBOLDT BAY, CALIFORNIA

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INTRODUCTION

This is a habitat suitability index model for songbird species that use forested or scrub-shrub wetlands (Cowardin *et al.* 1979) in the Humboldt Bay watershed in northern California; these wetlands are defined further below. The model can be used in determining existing habitat values, and in projecting habitat values at sites restored as wetlands. In addition, the model can be used to determine mitigation requirements for developments proposed to be sited in wetlands.

The model may be useful in determining habitat suitability in other wetland areas along the Pacific coast. Such application will require that users examine the model in order to determine whether local use necessitates model modification.

The model is based upon a review and synthesis of existing information, derived from the scientific literature, unpublished research reports available from Humboldt State University, comments from local biologists, and the author's personal observations. It is an hypothesis of species/habitat relationships, and is not a statement of proven cause and effect. It represents suspected relationships between habitat factors and the carrying capacity of the habitat for species in the guild. The model is scaled to produce a Habitat Suitability Index (HSI) value between 0.0 (unsuitable habitat) and 1.0 (optimally suitable habitat). Further discussion of HSI models may be obtained from part 103 of the Ecological Services Manual (see references).

This model has not been reviewed by species experts. The model has been reviewed by individuals familiar with HSI modelling, and modified according to their comments. The model has not been tested in the field.

The model is based on the perception that songbird species of riparian or swamp wetlands in the Humboldt Bay watershed form a guild in the sense used by Root (1967), Holmes *et al.* (1979), and Verner (1984). Further discussion of this use of the guild concept will be provided separately. This use of the term does not correspond to that advanced by Short (1983, 1984; Short and Burnham 1982).

Riparian habitat is used by a number of bird species, from a variety of avian families. This model is restricted to species that use the plants within this habitat directly for food, either through consumption of plant materials or through consumption of invertebrates that consume the plants, and that also nest (or potentially nest) within the habitat type. Most such species are members of the avian order Passeriformes. This model also addresses habitat needs of species in the order Piciformes (woodpeckers), at least two of which may be encountered foraging with passerines during the winter.

LIFE HISTORY OVERVIEW

Bird species potentially covered by this model include resident (i.e., remaining in the watershed all year), breeding visitor (here from spring through early fall), and winter visitor (here from fall through early spring) species. Examples of the three groups include: (i) resident - Chestnut-backed Chickadee (scientific names of all species are included in Attachment A), Downy Woodpecker, and Winter Wren; (ii) breeding visitor - Wilson's Warbler, Swainson's Thrush, and Tree Swallow; and (iii) winter visitor - Ruby-crowned Kinglet, Yellow-rumped Warbler, and Fox Sparrow. Additional species (such as the American Robin) are present all year, but probably are represented by different individuals in the winter and breeding seasons.

A vast quantity of ornithological and ecological literature exists covering the use of riparian wetlands by passerine and other birds; it is inappropriate to cite or synopsize it all here, but interested readers may wish to review Stevens et al. (1977), Hehnke and Stone (1979), Gaines (1980), Swift et al. (1984), and a number of papers in Warner and Hendrix (1984). There are currently two Master's thesis projects underway at Humboldt State University that include investigations of use of riparian and/or swamp habitats by songbirds in the Humboldt Bay area; one has resulted in interim reports that are useful in this analysis (Kelly 1983).

The specific habitat requirements of the species in this guild are rather varied. It is not the purpose of the model to address the conditions that would make riparian habitat more or less desirable for the individual species. The ecological backgrounds of the species are also varied: some species are almost completely "insectivorous" (consumers of arthropods), while some are primarily seed-eaters, and yet others consume both arthropods and seeds, as well as other plant material (see Martin et al 1951).

In order to address this variability, attention must be restricted to common elements in the ecology of the species. James (1971) demonstrated a "niche gestalt" for each of a number of passerine species. This interpretation is commonly adopted by ornithologists, and a number of "guild" studies (e.g., Holmes _et al._ 1979) utilize the concept of habitat conformation as a major element in defining guild membership. That approach is used in this model.

The bird species covered here are generally associated with deciduous tree and shrub species. It appears that the annual burst of production in the spring provides food for arthropods that compose the primary diet of most species, or food for the birds themselves. There is a general recognition that the diversity of bird species in an area generally is correlated with the vertical and horizontal foliage distribution (MacArthur and MacArthur 1961, Roth 1976, Holmes _et al._ 1979, Niemi and Hanowski 1984, Swift _et al._ 1984, and many others). Greater diversity in foliage distribution thus generally leads to greater bird species diversity. This correlation essentially ignores the actual relationship between productivity and reproductive success that presumably underlies the evolution of the habitat preferences.

It has been noted (e.g., Sturman 1968) that one of the species in this guild that is present in this watershed (the Chestnut-backed Chickadee) may respond to the presence or abundance of coniferous tree species. Observations in this region, and in other parts of California in which this species occurs, indicate that the chickadee does in fact use deciduous vegetation regularly. However, inclusion of conifers in riparian wetlands in the vicinity of Humboldt Bay has been recognized as the natural condition in these wetlands prior to settlement by European man (see Ray _et al._ 1984). For the purposes of this model, no differentiation will be made between deciduous and coniferous vegetation.

The distribution of foliage provides nesting substrate for the birds (each according to the appropriate niche gestalt). Some species in the guild are primary or secondary cavity nesters (secondary = using holes made by primary excavators). Cavity nesters generally use dead wood, rather than nesting in live trees. Thus, the presence of snags or other dead substrate is an important element for some species in the guild (see Schroeder 1982b, 1982c).

HABITAT REQUIREMENTS

This model addresses life requisites of food and foraging, reproduction (nesting), and cover. It is assumed that water is not limiting for any species, and no explicit element for water is included in this model. Food and foraging substrate are considered to be provided by woody vegetation. Shrubs are considered to be live woody stems up to 3 meters (10 feet) tall. Live woody stems greater than 3 m tall are considered to be trees. This model will not differentiate between single and multiple tree canopy layers, with possibly higher habitat values because of the presence of additional layers, primarily for logistical reasons.

Stem diameter is not considered for foraging purposes, although it is clear that scansorial (trunk- and limb-foraging) birds will experience greater habitat value as basal area increases (e.g., see Schroeder 1982c).

Similarly, cover is considered to be provided by vegetation; separate variables to differentiate between foraging and cover substrates are not included in the model.

Reproduction substrate is provided for these species by the plants that also provide cover and foraging substrate. The volume of space that potentially offers nesting sites increases proportionally with the total volume of plant leaf area. A further consideration for nesting substrate is the availability of snags of suitable size, to accommodate cavity nesters.

HABITAT SUITABILITY INDEX [HSI] MODEL

Model Applicability. This model was developed to address habitat needs within the Humboldt Bay watershed. The model is also expected to apply to coastal wetlands elsewhere on California's northern coast, although the full range of geographical applicability is not defined. The model may be applicable (with suitable modifications) to other coastal and noncoastal wetland areas in California and Oregon; many northwestern California wetlands are more similar to those of Oregon than to wetlands farther south in California. There is no intended seasonal applicability, inasmuch as the habitats covered by the model are used by different members of the guild in all four seasons.

Wetlands included in the habitats that could be evaluated by this model are: (i) riparian woodlands along streamcourses that enter the bay; (ii) swamps dominated by willows (*Salix* spp.), alders (*Alnus oregona*), and waxmyrtles (*Myrica californica*), most of which occur in saturated or poorly drained soils; and (iii) similar wetlands with emergent woody vegetation. Cowardin *et al.* (1979) note that scrub-shrub and forested wetlands are restricted to "palustrine" and "estuarine" wetlands; in Humboldt Bay, only palustrine wetlands include these habitats. Readers should review Cowardin *et al.* (1979) for additional information regarding classification of wetlands, and examples of wetland habitats.

One variable used in the model (number six, below) requires information that may be obtained from maps or aerial photographs. All other variables require field sampling. Model users are expected to exercise adequate rigor in sampling and analysis, so that statistical validity is ensured. Although there is no mandatory season for sampling, it is recommended that sampling be conducted when tree and shrub canopies are in leaf.

The model is intended to be applied to habitat areas that may not be entirely one cover type (i.e., a site may contain emergent wetland as well as woody vegetation). This formulation accommodates changes in wetland area through time, as would be expected in wetland restoration or enhancement projects; suitability is related to the fraction of the area presenting appropriate habitat conditions. A functionally similar (but not exactly identical) model would result if the sixth variable were omitted and the model applied only to ripa[illegible] wetlands. As noted below, the model includes a "minimum area" assumption, a requirement that the model only be applied to habitat areas with at least 20 square meters of riparian vegetation.

<u>Description of the Model.</u> This model is based upon the two basic habitat parameters noted above, the presence and volume of foliage and the presence of suitable snags. The model uses several variables to account for foliage characteristics. This is considered appropriate, in view of the presumed importance of foliage in providing foraging area, cover, and nesting substrate for most of the species in this guild. The model includes one variable covering snag availability. It also includes a variable scaling the suitability of an evaluation site according to the fraction of the site that has appropriate vegetation.

The first and second variables relate suitability to the percent of canopy closure in two vegetational layers. Canopy closure is directly related to canopy foliage volume (see, for example, Hays <u>et al.</u> 1981). Each variable relates to foliage volume in two horizontal dimensions within a specific "layer" of the habitat (see next section). Site suitability increases with foliage volume, until there is enough foliage to begin shading lower layers, thus reducing ecological productivity in those layers. It is to be expected, therefore, that intermediate values for canopy closure provide optimal habitat. The third variable scales foliage volume in the vertical dimension.

The first and second variables are expressed as canopy cover, which is the percentage of the ground surface covered by a vertically downward projection of aerial foliage. While some ecological studies express cover in terms of specific layers or of total numbers of foliage layers, this model will use cover in the botanical sense as just defined.

The assumption that intermediate cover values are optimal follows from the use of ground-level vegetation by species that should be evaluated by this model. Complete canopy closure generally leads to a loss of live ground cover. Ground cover vegetation is not measured by this model; however, incomplete canopy cover in the shrub and tree layers is anticipated to lead to appropriate live plants at ground level.

All of the above variables are scaled by the fourth variable to reflect the overall canopy "layering" within the vegetation. Habitat value increases as the amount of layering increases (see next section for details).

The fifth variable in this model is a measure of the density of snags of minimally acceptable size for cavity nesters. Site suitability increases with snag density until optimal conditions are reached. This may not address site suitability adequately for some habitat conditions, as both more snags and larger snags may improve a site for some bird species. However, it is believed that the variable incorporated into this model addresses the needs of the small passerine and woodpecker species primarily covered by this model.

The sixth variable scales the habitat value in direct proportion to the fraction of the site that provides the other variables. If there is no woody riparian vegetation, the site [illegible]. It is presumed that a vegetation patch must have a minimum area of approximately 20 square meters (about 215 square feet) to provide habitat utility.

Suitability Index [SI] Graphs for Model Variables. Following in Figure 1 are graphic representations of presumed relationships between habitat variables and habitat suitability. The SI values are read directly from the graph (1.0 = optimal suitability; 0.0 = no suitability) for each variable. The rationale for developing each graph is presented below.

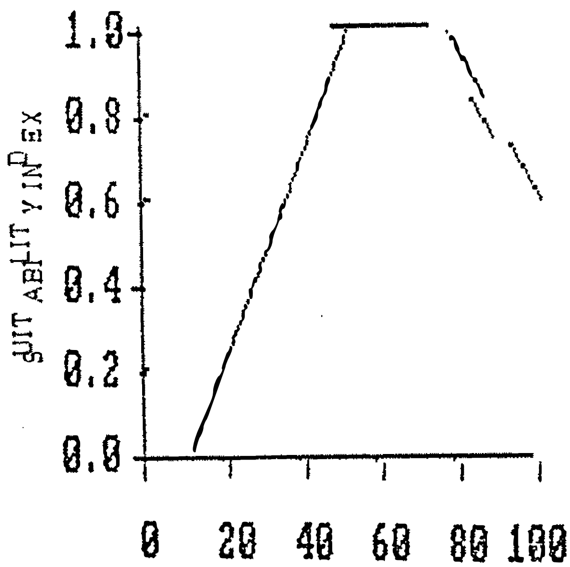
Variable 1: DSCCP - Percent shrub (1 - 3 meter tall) canopy cover. The model assumes that foliage must be present before the habitat is suitable at all. This variable is structured to reflect habitat utility when the foliage in the shrub canopy covers at least 10 percent of the ground surface (see previous section). Suitability increases to an optimum when 50% - 75% of the site has shrub canopy cover. These cover levels provide relatively dense foliage within the shrub layer, while allowing some light to pass through to the ground level.

As the canopy closes, lower light levels at the ground surface restrict vegetation growth. It appears that there will be a tradeoff between increased suitability for species that use the shrub canopy and decreased suitability for species that use the forest floor. The SI value is assumed to decrease to 0.6 at 100% canopy closure. This value greater than one-half should reflect the contribution to habitat of the foliage volume in three dimensions above the ground, as contrasted with the two dimensions at ground level. It should be noted that this variable is modified from Schroeder (1982a).

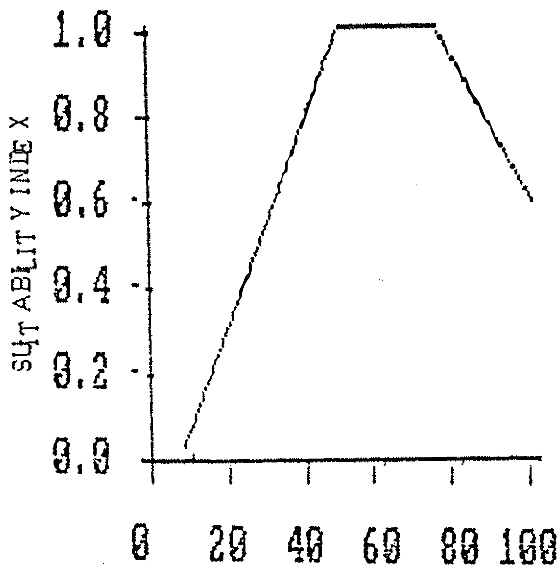
Variable 2: CC3MP - Percent tree (greater than 3 meter tall) canopy cover. This variable is similar to variable 1. At least 10% of the site's ground surface must lie under tree canopy for any suitability to exist. Suitability increases to optimum levels at 50% to 75% cover, then decreases to intermediate values as canopy cover approaches 100% (for identical reasoning).

This variable does not differentiate the canopy into lower and higher levels, as the expected use of the model is within riparian or swamp habitats near Humboldt Bay, where canopy heights rarely exceed 6 m and one canopy layer. Were the model to be applied to other riparian forests, where canopy heights can reach 10 m, and where there may be more than one distinct tree canopy layer, it would be appropriate to restructure this variable (or the entire model) to reflect the additional layering. This variable is modified from Schroeder (1982b).

Variable 3: NAHOT - Average height of overstory trees (in meters). This variable reflects the vertical dimension of the foliage; habitat utility should increase with the value of the variable. As with other variables in the model, a threshold exists; vegetation must be at least 1 m tall before it provides habitat value. The SI increases with canopy height until the height



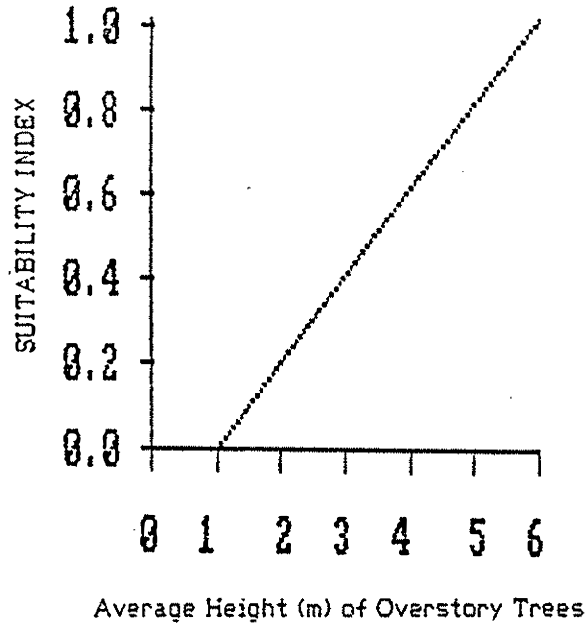
Percent Shrub (1 - 3 m Tall) Canopy Cover



Percent Tree (> 3 m tall) Canopy Cover

FIGURE 1A - SUITABILITY INDEX GRAPHS

OSCAR LARSON & ASSOCIATES



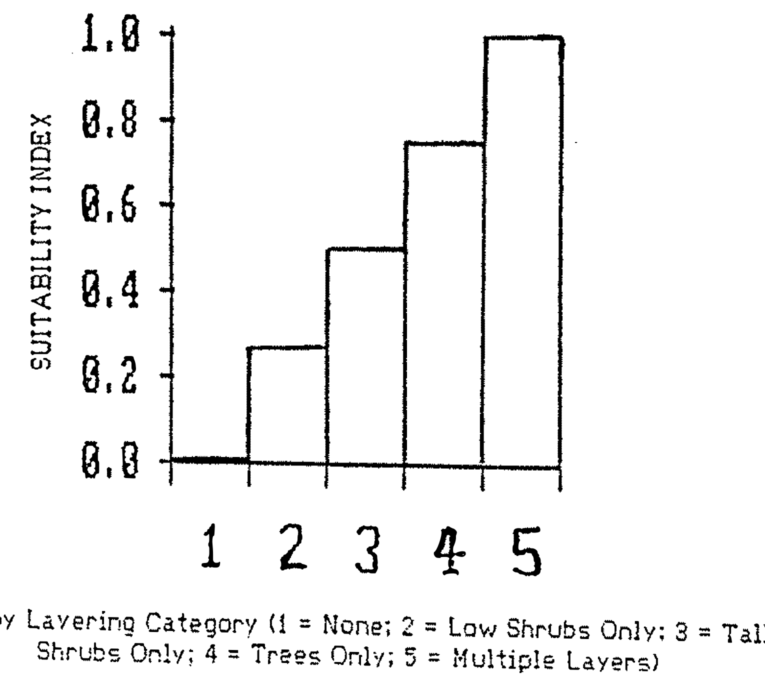


FIGURE 1B - SUITABILITY INDEX GRAPHS

reaches 6 m (20 feet). Willows and other trees in Humboldt Bay riparian habitats seldom exceed this height, and it thus represents an approximate maximum value. This variable is modified from Schroeder (1982b).

Variable 4: CNLAY - Canopy layering categories (1, 2, 3, 4, or 5). This variable requires an input scalar value from the user, depending upon the general conformation of the habitat. The scalar values and the associated SI values are shown in Figure 1: Category 1 - no woody vegetation; Category 2 - low shrubs, less than a meter tall; Category 3 - tall shrubs, 1 to 3 m tall; Category 4 - trees, more than 3 m tall but without woody understory; and Category 5 - multiple layers of woody vegetation, with both trees and shrubs present.

This variable is used in the model to scale vertical habitat heterogeneity. Greater value follows from more diverse habitat. Alternate measures of this variable are available (e.g., MacArthur and MacArthur 1961), but this formulation is more direct and is easier to measure.

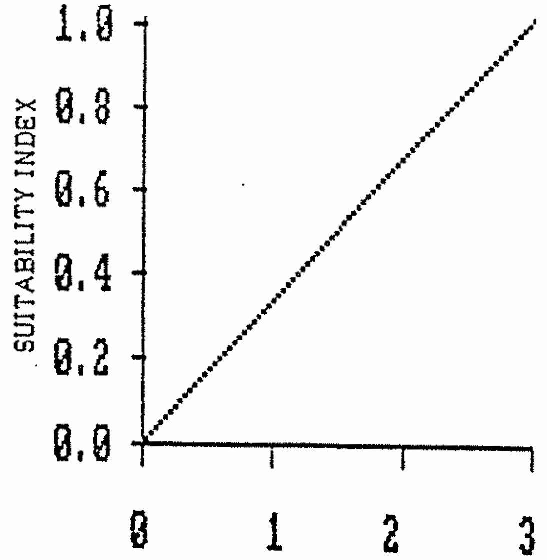
Variable 5: DSNAG10 - Number of snags greater than 10 cm diameter at breast height (dbh) per 0.4 hectare (greater than 4 inches dbh per acre). Since several members of this guild require cavities, the suitability of a site increases with the density of snags of appropriate size. This variable produces a linear increase in suitability if any snags at least 10 cm in diameter are present, reaching an optimum when three or more are present per acre.

Were this model to be applied to more diverse riparian habitats than Humboldt Bay, this variable should be modified to require larger snags for optimum suitability. Small trees and snags are adequate for small bird species, but do not serve for large birds, or for mammals and other potential cavity users. This variable is modified from Schroeder (1982b, 1982c); the optimum level of 3 snags per acre is a compromise from the two previous models.

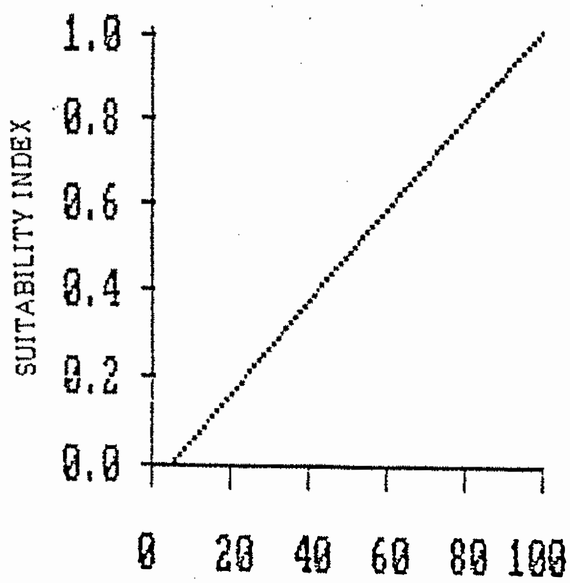
Variable 6: APWRV - Percent of the site in woody riparian vegetation. This variable scales the habitat suitability of a site according to the fraction that provides appropriate vegetation. From a threshold value at 5% of the site, the value increases linearly to optimality when 100% of the site provides riparian vegetation. As noted above, a presumed threshold size of 20 square meters of woody vegetation is required for this variable to be applicable.

HSI Determination. The riparian songbird guild model is shown in Figure 2; a printout of the electronic version of the model is included in Attachment B.

The overall suitability of a riparian or swamp wetland for the species in Attachment 1 is evaluated by this model in terms of the distribution of foliage, by the presence and number of snags, and by the fraction of the evaluation site containing such vegetation. Variables 1 through 4 in the model address vegetation, and the remaining parameters are addressed by



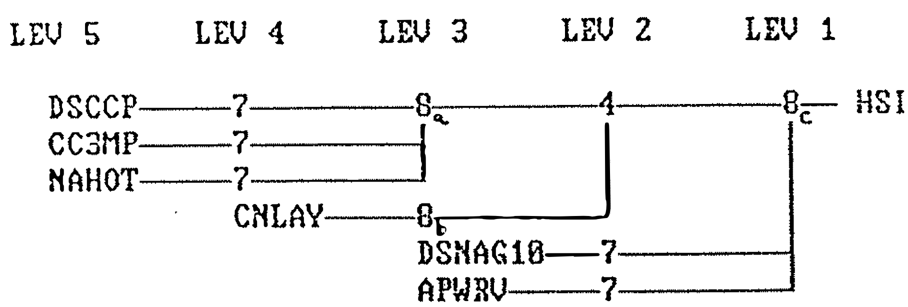
Number of Snags > 10 cm DBH per 0.4 ha (> 4 inches DBH per acre)



Percent of Site in Woody Riparian Vegetation

FIGURE 1C - SUITABILITY INDEX GRAPHS

OSCAR LARSON & ASSOCIATES



TREE DIAGRAM FOR THE RIPARIAN SONGBIRD GUILD MODEL

DOCUMENTATION

1. Values of input variables are entered according to variable definitions and Table 1.

2. Function code "4" is a geometric mean; e.g., $Y = (X_1 * X_2)^{\frac{1}{2}}$.

3. Function code "7" is a graph; see Figure 1. Output from graph is a value $0.0 \leq Y \leq 1.0$.

4. Function code "8" is a user-specified function. Input values (left side of function code in figure) are numbered 1, 2, etc., from top down.

Equations are: 8_a: $Y = (X_1 + X_2 + 2.0*X_3)/4.0$.

8_b: see Figure 1b.

8_c: $HSI = ((X_1 + X_2)/2.0) * X_3$.

FIGURE 2 - MODEL TREE DIAGRAM AND DOCUMENTATION

variables 5 and 6 respectively.

Variables 1, 2, and 3 are combined in the model to reflect the volume of foliage present. The first two variables reflect horizontal foliage distributions, and the third the vertical distribution. Foliage in the shrub and tree canopy layers of the relatively low thickets in the watershed is assumed to be continuous, and the values for the two variables are deemed to be compensatory; a single value reflecting horizontal foliage dimensions is achieved by averaging the two variables.

The vertical dimension is incorporated into this model as part of the averaging calculation, to reflect the compensation between "layers." This variable is weighted at twice the value of the former variables, however, so that suitability calculations emphasize the vertical foliage distribution. Half of the output from the user-specified function thus relates to horizontal, and half to vertical, foliage distribution (see Fugure 2).

The intermediate suitability index value provided by the calculation above is modified in the model by the suitability index derived from the canopy layering present. The model combines the foliage variables via a geometric mean function. This is used to reflect the partial compensation between foliage volume and layering criteria, and the increased departure from optimum conditions when either of the factors is much less than optimum. The output from this computation thus emphasizes any departure from optimum foliage distribution conditions.

The habitat suitability index (HSI) is computed in the model with a user specified function. The function calculates the arithmetic mean of the foliage and snag variable values. This is appropriate when the variables are fully compensatory, so that high values of one offset low values of the other. This appears reasonable in this case; good foraging area might not provide many snags for nesting (or vice versa), but the favorability of the site for foraging still maintains a relatively high utility for the habitat. The function also reduces the index value according to the fraction of the site that is not in appropriate vegetation.

In general terms, the HSI value is determined approximately half by foliage value and half by snag value. About a quarter of the value relates to canopy layering, and a quarter to the combination of cover values and total canopy height.

FIELD USE OF THE MODELS - SAMPLING

Suggested sampling techniques for the variables in the riparian songbird guild HSI model are indicated in Table 1. Readers should consult Hays et al. (1981) for specific discussion of sampling techniques useful in determining habitat suitability. Other sampling techniques may be substituted if equivalent results are produced.

Table 1. Suggested measurement techniques for variables in the riparian songbird guild model.

Variable	Suggested Measurement Technique
DSCCP: percent shrub (1-3 m tall) canopy cover.	Establish a baseline transect through the habitat area. At regular intervals, establish sample transects perpendicular to the baseline. Using a random sampling procedure (such as random numbers to determine distances along transects), establish sample plots at least 1 square meter in area. Estimate percentage shrub canopy cover (the area on the ground surface covered by aerial foliage of woody-stemmed plants 1 to 3 meters tall) to the nearest 5% interval. Recommended: sample at least 20 points. Compute average coverage for all samples.
CC3MP: percent tree (>3 m tall) canopy cover.	Establish a baseline transect as above, with sampling transects perpendicular to baseline. Sample as for DSCCP, except that percentage cover should be estimated for trees (woody plants >3 m tall). Recommended: sample at least 20 points. Compute average coverage for all samples.
NAHOT: average height (m) of overstory trees.	Use sample points identified for CC3MP. Obtain a single measurement of tree canopy height for each point. Measure canopy height as the tallest (highest) vegetation in the quadrat sampled. Compute average of all sampled values. [Note: if there are no trees (plants >3 m tall), measure the canopy height of shrubs.]
CNLAY: canopy layering category (1, 2, 3, 4, or 5).	For each sample point for DSCCP and CC3MP, record the presence or absence of trees, shrubs (as defined above), and woody stems <1 m tall. When sampling is complete, inspect these records. Assign an ordinal value (1, 2, 3, 4, or 5) according to these records, considering all data together. [Note: this variable is intended to involve the user's judgement about the entire site. The value assigned should be biologically justifiable.]
DSNAG10: number of snags >10 cm diameter at breast height (dbh) per 0.4 ha (>4 inches dbh per acre).	For each sample point for DSCCP and CC3MP, record the number of snags in the quadrat meeting this screening criterion (>10 cm dbh). Compute the total number of snags observed and the total area sampled. Convert to 0.4 ha (acre) density value.
APWRV: percent of the site in woody riparian vegetation.	Using aerial photo or map of entire evaluation area, compute total area. Also compute area covered by woody "riparian" vegetation. Divide latter area by total and multiply by 100. Alternatively, lay out a grid of points over entire evaluation area; ensure that grid covers the entire study area, but exclude all areas outside study boundary. Tally the number of grid points falling in appropriate vegetation, divide by the total number of grid points, and multiply by 100.

OTHER MODELS

The U.S. Fish & Wildlife Service has published HSI models for the Yellow Warbler (Schroeder 1982a), the Black-capped Chickadee (Schroeder 1982b), and the Downy Woodpecker (Schroeder 1982c). The third species is resident in the Humboldt Bay watershed, and the first uses habitats here during migration. The Chestnut-backed Chickadee uses habitats somewhat like those used by the Black-capped Chickadee (see above and Sturman 1968). The three published models were reviewed in preparing this model, and portions were incorporated. The author is not aware of other published or unpublished HSI models for species in this guild, or of models in any stage of development for the guild as a whole.

ACKNOWLEDGEMENTS

This model was prepared under contract with the California State Coastal Conservancy. Preliminary research regarding habitat variables was conducted under contract with the County of Humboldt. Assistance from Liza Riddle of the Conservancy and from Don Tuttle and Andrea Pickart of the County of Humboldt Department of Public Works made model development possible. HSI modelling software was obtained from the Western Energy and Land Use Team, U.S. Fish & Wildlife Service, Fort Collins, Colorado.

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ATTACHMENT A

The following species are expected to derive habitat utility from the riparian or "swamp" habitat type covered by this model. This is considered a minimum list; other species not recorded here also should benefit. Listing order is taxonomic, and does not imply importance, abundance, or degree of benefit. The list is based upon references cited in the model.

Taxonomic Name	Common Name
Picoides pubescens	Downy Woodpecker
Picoides villosus	Hairy Woodpecker
Empidonax difficilis	Western Flycatcher
Tachycineta bicolor	Tree Swallow
Parus rufescens	Chestnut-backed Chickadee
Troglodytes troglodytes	Winter Wren
Turdus migratorius	American Robin
Ixoreus naevius	Varied Thrush
Catharus guttatus	Hermit Thrush
Catharus ustulatus	Swainson's Thrush
Regulus calendula	Ruby-crowned Kinglet
Vermivora celata	Orange-crowned Warbler
Dendroica petechia	Yellow Warbler
Dendroica coronata	Yellow-rumped Warbler
Wilsonia pusilla	Wilson's Warbler
Carduelis tristis	American Goldfinch
Passerella iliaca	Fox Sparrow
Melospiza melodia	Song Sparrow

ATTACHMENT B

LIBRARY: B:HUMBAY.LIB
07-26-1986

MODEL # 5
MODEL NAME: RIPARIAN SONGBIRD GUILD AUTHOR DRAFT 04-15-1986

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Schroeder. R.L. 1982. Habitat suitability index models: Downy Woodpecker. U.S. Dept. Int. Fish. Wildl. Serv. FWS/OBS-82/10.38. 10 p.

See written version for further references.

```
LEV 5      LEV 4      LEV 3      LEV 2      LEV 1
 DSCCP-----7---------8----------4---------8-- HSI
 CC3MP-----7---------|          |         |
 NAHOT-----7---------^          |         |
           CNLAY-----8----------^         |
                     DSNAG10---7----------|
                     APWRV-----7----------^
```

DSCCP Percent shrub (1-3m tall) canopy cover.
CC3MP Percent tree (>3m high) canopy cover.
NAHOT AVERAGE HEIGHT OF OVERSTORY TREES (M)
CNLAY Canopy layering categories (1,2,3,4, or 5) - see model documentation.
DSNAG10 Number of snags >10cm dbh per 0.4 ha (>4 in dbh per acre).
APWRV Percent of site in woody riparian vegetation.

GRAPH FUNCTION AT LEVEL 4 , POSITION 1
Title: DSCCP

X=	Y=
0.000	0.000
10.000	0.000
50.000	1.000
75.000	1.000
100.000	0.600
110.000	0.600

GRAPH FUNCTION AT LEVEL 4 , POSITION 2
Title: CC3MP

X=	Y=
0.000	0.000
10.000	0.000
50.000	1.000
75.000	1.000
100.000	0.600
110.000	0.600

odel: RIPARIAN SONGBIRD GUILD (continued)

```
RAPH FUNCTION AT LEVEL 4 . POSITION 3
 Title:  HOT
   X=       0.000     Y=       0.000
            1.000              0.000
            6.000              1.000
            7.000              1.000

SER-SPECIFIED FUNCTION AT LEVEL 3 . POSITION 1
SUB = (X(1)+X(2)+2.*X(3))/4.

SER-SPECIFIED FUNCTION AT LEVEL 3 . POSITION 2
F X(1)<>1 AND X(1)<>2 AND X(1)<>3 AND X(1)<>4 AND X(1)<>5 THEN PRINT:PRINT"***
ERROR IN INPUT***":PRINT"VALUE FOR CNLAY MUST BE 1. 2. 3, 4. OR 5.":PRINT"PRESS
ANY KEY TO RETURN TO DATA MODIFICATION MENU  -  "::Z$ = INPUT$(1):GOTO 9010
F X(1) = 1 THEN USUB = 0
F X(1) = 2 THEN USUB = .25
F X(1) = 3 THEN USUB = .5
F X(1) = 4 THEN USUB = .75
F X(1) = 5 THEN USUB = 1.

RAPH FUNCTION AT LEVEL 2 . POSITION 2
 Title:  SNAG10
   X=       0.000     Y=       0.000
            3.000              1.000
            4.000              1.000

RAPH FUNCTION AT LEVEL 2 . POSITION 3
 Title:  PWRV
   X=       0.000     Y=       0.000
            5.000              0.000
          100.000              1.000
          110.000              1.000

SER-SPECIFIED FUNCTION AT LEVEL 1 . POSITION 1
SUB = ((X(1)+X(2))/2.)*X(3)
```

COMMUNITY-BASED HABITAT SUITABILITY INDEX MODEL FOR THE RIPARIAN FOREST COVER-TYPE ALONG LLAGAS CREEK

Adapted from a model used by the HEP team evaluating impacts of proposed riprap bank protection along the lower Sacramento River

As Revised
September 2001

BACKGROUND: The cover-type model described here is for Riparian Forest Cover. This cover-type is defined as a stand of woody vegetation composed of primarily trees greater than 20-feet-tall. The Riparian Forest cover-type model identifies and quantifies characteristics of this cover type which are important to a wide array of wildlife. The model does not attempt to portray exactly the needs of any one species, but rather it broadly portrays the needs of many species or species groups of riparian zones along Llagas Creek.

For example, many birds, including nesting raptors such as red-tailed hawks and re-shouldered hawks require tall trees, and thus tree height, with taller trees being more favorable, has been included as a key model variable. Also, many songbirds, such as the northern oriole and least Bell's vireo, require relatively dense canopies, thus canopy closure, with greater closure providing greater value, is included as a model variable. Similarly, riparian water birds such as herons an egrets have specific needs relating to canopy closure, width of stand, and density of vegetative understory, so these needs have been met as much as possible with the appropriate model variables.

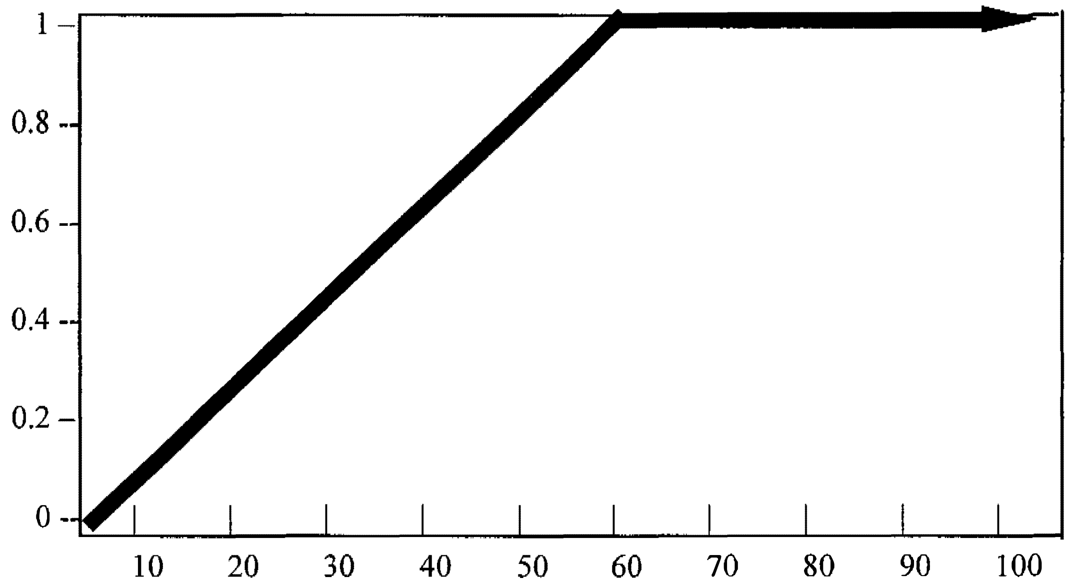
The single Habitat Suitability Index (HSI) value which is derived using the Riparian Forest cover-type model is therefore, not an exact measure of the habitat value of any single wildlife species. Instead, the HSI indicates the overall, broad quality of the cover-type to a broad array of the most important species which inhabit the creek's riparian zone. As such, the use of this single HSI value in the HEP process is assumed to provide the same results (i.e., estimates of relative impacts and compensation needs) as if the HEP were completed using a number of individual wildlife species models. Past comparisons using actual HSI data collected from Riparian Forest Cover along the Sacramento River suggest the validity of this assumption.

AREA OF APPLICABILITY: Riparian Forest Cover along Llagas Creek, a tributary of the Pajaro River.

VARIABLE

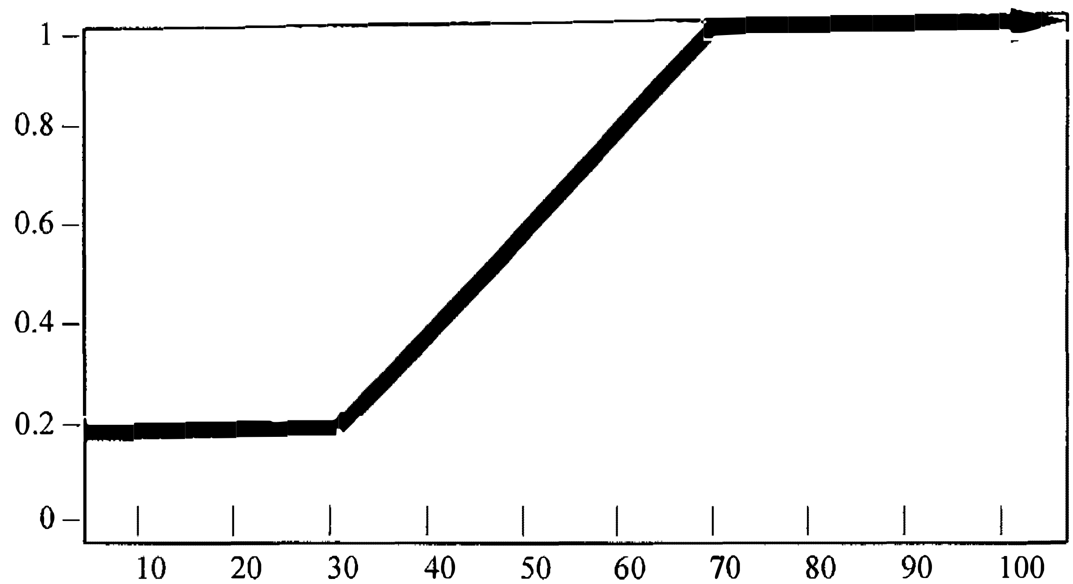
V_1 – Average tree height.
V_2 – Average canopy width of the stand.
V_3 – Tree canopy closure.
V_4 – Number of tree or shrub species.
V_5 – Understory vegetative density.

V_1 – Average tree height. Suitability Index (SI) determination. Assumptions: For most wildlife species of concern, the taller the trees, the better the habitat value. Nesting raptors in particular require relatively tall trees. A tree height, on average, of about 60 feet or greater is optimum.



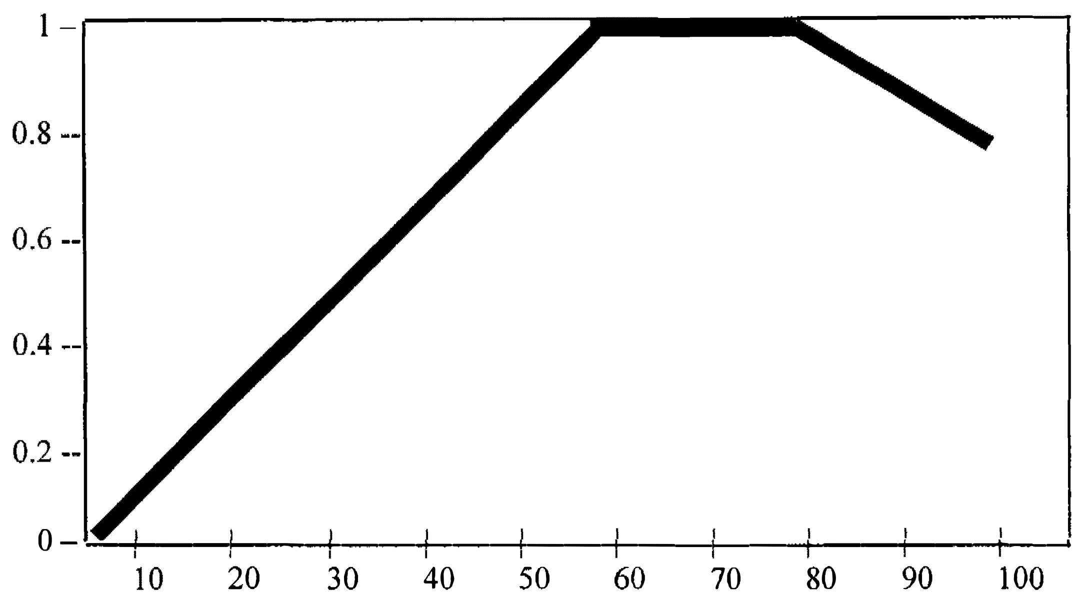
V_1 – Average Tree Height (Ft.)

V_2 – Average canopy width of the stand. Suitability Index (SI) determination. Assumptions: Generally, the wider the stand, the better the values for most key fish and wildlife. Stands less than 30-feet-wide have relatively low values; stands over 70 feet in width are best.



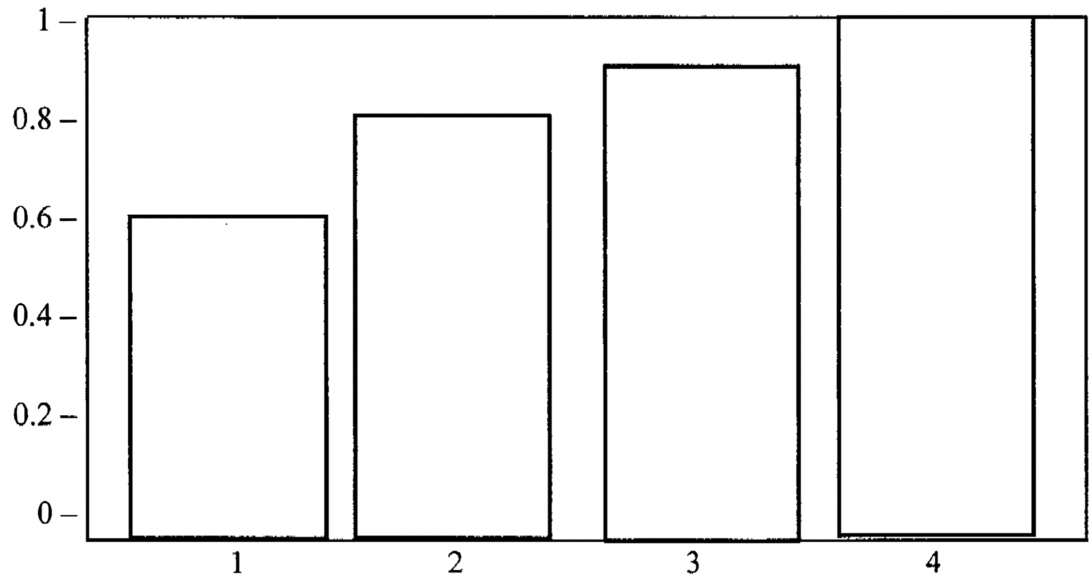
V_2 – Average Canopy Width of the Stand (Ft.)

V_3 – Tree canopy closure. Suitability Index (SI) determination. Assumptions: In general, the greater the forest density, as determined by percent of canopy closure, the greater the values of the forest. However, if the stand becomes too dense, habitat values frequently decline. The optimal condition is with percent canopy closure of 50 to 80 percent.



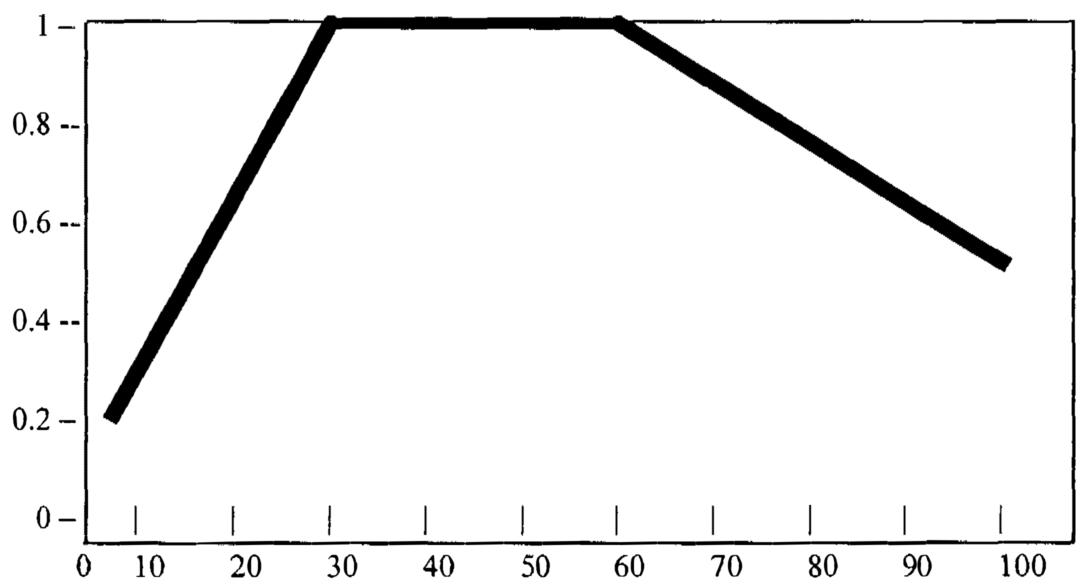
V_3 – Tree canopy closure (%)

V_4 – Number of tree or shrub species. Suitability Index (SI) determination. Assumptions: Habitat diversity improves carrying capacity. Generally, the more tree or shrub species present, the more diverse th forest, and the greater the values to fish and wildlife. The optimal condition is when the forest is composed of at least four species of trees.



V_4 – Number of Tree or Shrub Species

V_5 – Understory vegetative density. Suitability Index (SI) determination. Assumptions: The best Riparian Forest habitat occurs when both overstory and understory canopies are relatively dense. the understory should generally have a moderate density of vegetation at various elevations. By estimating the understory of the forest for the horizontal planes at 2, 6, and 14 feet above ground, and then averaging these three figures (i.e., the three estimates of percent vegetative cover), a good index of overall understory density can be derived.



V_5 – Average Understory Vegetative Density (%)
(At 2. 6. and 14 Feet Above Ground)

HABITAT SUITABILITY INDEX (HSI): Average canopy width and understory density are believed to be slightly more important variables than the other three variables. The five variables are thus combined as follows:

$$HSI = \frac{(V_1 \times V_3 \times V_4)^{1/3} + (V_2 \times V_5)^{1/2}}{2}$$

Variables are generally measured or estimated during periods of maximum vegetative leaf-out.

The calculated HSI is reduced by 40% when the majority of the tree canopy closure is from non-native species such as eucalyptus. In addition, this adjusted (or if not adjusted) HSI is further reduced by 33% if the edge of the riparian forest occurrence begins 20 feet or more away from the edge of the streambed, since riparian forest in close association with the stream has highest values.

FWS/OBS-82/10.38
APRIL 1983

HABITAT SUITABILITY INDEX MODELS: DOWNY WOODPECKER

Fish and Wildlife Service

U.S. Department of the Interior

This model is designed to be used by the Division of Ecological Services in conjunction with the Habitat Evaluation Procedures.

FWS/OBS-82/10.38
April 1983

HABITAT SUITABILITY INDEX MODELS: DOWNY WOODPECKER

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Project Officer

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Western Energy and Land Use Team
Division of Biological Services
Research and Development
Fish and Wildlife Service
U.S. Department of the Interior
Washington, DC 20240

This report should be cited as:

Schroeder, R. L. 1982. Habitat suitability index models: Downy woodpecker. U.S. Dept. Int., Fish Wildl. Serv. FWS/OBS-82/10.38. 10 pp.

PREFACE

This document is part of the Habitat Suitability Index (HSI) Model Series (FWS/OBS-82/10), which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information Section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. The habitat use information provides the foundation for HSI models that follow. In addition, this same information may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model Section documents a habitat model and information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The application information includes descriptions of the geographic ranges and seasonal application of the model, its current verification status, and a listing of model variables with recommended measurement techniques for each variable.

In essence, the model presented herein is a hypothesis of species-habitat relationships and not a statement of proven cause and effect relationships. Results of model performance tests, when available, are referenced. However, models that have demonstrated reliability in specific situations may prove unreliable in others. For this reason, feedback is encouraged from users of this model concerning improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning. Please send suggestions to:

Habitat Evaluation Procedures Group
Western Energy and Land Use Team
U.S. Fish and Wildlife Service
2627 Redwing Road
Ft. Collins, CO 80526

CONTENTS

ACKNOWLEDGMENTS

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DOWNY WOODPECKER (Picoides pubescens)

HABITAT USE INFORMATION

General

Downy woodpeckers (Picoides pubescens) inhabit nearly all of North America where trees are found (Bent 1939). They are rare or absent in arid desert habitats and most common in open woodlands.

Food

The downy woodpecker is primarily an insectivore; 76% of the diet is animal foods, and the remainder is vegetable food (Beal 1911). Beetles, ants, and caterpillars are the major animal foods, and vegetable foods include fruits, seeds, and mast. Downy woodpeckers feed by digging into the bark with the bill, by gleaning along the bark surface, and, infrequently, by flycatching (Jackson 1970).

Downy woodpeckers in Illinois foraged more in the lower height zones of trees than in the tree canopies and foraged more often on live limbs than on dead limbs (Williams 1975). Similarly, downy woodpeckers in Virginia foraged primarily on live wood in pole age and mature forests (Conner 1980). Downy woodpeckers in New York spent 60% of their foraging time in elms (Ulmus spp.) (Kisiel 1972). They foraged most frequently on twigs 2.5 cm (1 inch) or less in diameter, and drilling was the foraging technique used most often. Downy woodpeckers are not strong excavators and do not excavate deeply to reach concentrated food sources, such as carpenter ants (Camponotus spp.) (Conner 1981).

Downy woodpeckers in Virginia foraged in the breeding season in habitats with a mean basal area of 11.3 m^2/ha (49.2 ft^2/acre). Habitats used for foraging during the postbreeding and winter seasons had significantly higher mean basal areas of 21.4 m^2/ha (93.2 ft^2/acre) and 17.2 m^2/ha (74.9 ft^2/acre), respectively. Downy woodpeckers in New Hampshire fed heavily in stands of paper birch (Betula papyrifera) that were infected with a coccid (Xylococchus betulae) (Kilham 1970). The most attractive birches for foraging were those that were crooked or leaning, contained broken branches in their crown, and had defects, such as cankers, old wounds, broken branch stubs, and sapsucker drill holes. Downy woodpeckers invaded an area in Colorado in high numbers during the winter months in response to a severe outbreak of the pine bark beetle (Dendroctonus ponderosae) (Crockett and Hansley 1978). This outbreak of beetles had not resulted in increased breeding densities of the woodpeckers at the time of the study.

Downy woodpeckers foraged more on tree surfaces during summer than in winter (Conner 1979). They increased the amount of time spent in subcambial excavation in winter months, probably in response to the seasonal availability and location of insect prey. Downy woodpeckers appear to broaden all aspects of their foraging behavior in the winter in order to find adequate amounts of food (Conner 1981).

Downy woodpeckers in Ontario extracted gall fly (Eurosta solidaginis) larvae from goldenrod (Solidago canadensis) galls growing near forest edges (Schlichter 1978). Corn stubble fields supported small winter populations of downy woodpeckers in Illinois (Graber et al. 1977).

Water

Information on the water requirements of the downy woodpecker was not located in the literature.

Cover

The cover requirements of the downy woodpecker are similar to their reproductive requirements, which are discussed in the following section.

Reproduction

The downy woodpecker is a primary cavity nester that prefers soft snags for nest sites (Evans and Conner 1979). These woodpeckers nest in both coniferous and deciduous forest stands in the Northwest. Nests in Virginia were common in both edge situations and in dense forests far from openings (Conner and Adkisson 1977). Downy woodpeckers in Oregon occur primarily in deciduous stands of aspen (Populus tremuloides) or riparian cottonwood (Populus spp.) (Thomas et al. 1979). The highest nesting and winter densities in Illinois were in virgin or old lowland forests (Graber et al. 1977).

Downy woodpeckers in Virginia preferred to nest in areas with high stem density, but with lower basal area and lower canopy heights than areas used by the other woodpeckers studied (Conner and Adkisson 1977). They preferred sparsely stocked forests commonly found along ridges (Conner et al. 1975). Preferred nest stands had an average basal area of 10.1 m^2/ha (44 ft^2/acre), 361.8 stems greater than 4 cm (1.6 inches) diameter/ha (894/acre), and canopy heights of 16.3 m (53.5 ft) (Conner and Adkisson 1976). Downy woodpeckers in Tennessee were frequently seen feeding in the understory and apparently selected habitats with an abundance of understory vegetation (Anderson and Shugart 1974).

Downy woodpeckers excavate their own cavity in a branch or stub 2.4 to 15.3 m (8 to 50 ft) above ground, generally in dead or dying wood (Bent 1939). There was a positive correlation between downy woodpecker densities and the number of dead trees in Illinois (Graber et al. 1977). Downy woodpeckers rarely excavate in oaks (Quercus spp.) or hickories (Carya spp.) with living cambium present at the nest site (Conner 1978). They apparently require both sap rot, to soften the outer part of trees, and heart rot, to soften the interior, when hardwoods, and possibly pines, are used for nesting. Downy woodpeckers in Virginia nested mainly in dead snags with advanced stages of fungal heart rot (Conner and Adkisson 1976).

Downy woodpeckers "search image" of an optimal nest site is a live tree with a broken off dead top (Kilham 1974). Suitable nest trees are in short supply in most areas and appear to be a limiting factor in New Hampshire. Downies in Montana appeared to prefer small trees, possibly to avoid the difficulty of excavating through the thick sapwood of large trees (McClelland et al. 1979). The average dbh of nest trees (n = 3) in Montana was 25 cm (10 inches). All 11 nests in an Ontario study were in dead aspen, and the average dbh of four of these nest trees was 26.2 cm (10.3 inches) (Lawrence 1966). Fourteen of 19 nest trees in Virginia were dead, the average dbh of nest trees was 31.8 cm (12.4 inches), and nest trees averaged 8.3 m (27.2 ft) in height (Conner et al. 1975).

Thomas et al. (1979) estimated that downy woodpeckers in Oregon require 7.4 snags, 15.2 cm (6 inches) or more dbh, per ha (3 snags/acre). This estimate is based on a territory size of 4 ha (10 acres), a need for two cavities per year per pair, and the presence of 1 useable snag with a cavity for each 16 snags without a cavity. Evans and Conner (1979) estimated that downies in the Northeast require 9.9 snags, 15 to 25 cm (6 to 10 inches) dbh, per ha (4 snags/acre). Their estimate is based on a territory size of 4 ha (10 acres), a need for four cavity trees per year per pair, and a need for 10 snags for each cavity tree used in order to account for unuseable snags, a reserve of snags, feeding habitat, and a supply of snags for secondary users. Conner (pers. comm.) recommended 12.4 snags/ha (5 snags/acre) for optimal downy woodpecker habitat.

Interspersion

Downy woodpeckers occupy different size territories at different times of the year (Kilham 1974). Fall and winter territories consist of small, defined areas with favorable food supplies and the area near roost holes. Breeding season territories consist of an area as large as 10 to 15 ha (24.7 to 37.1 acres) used to search out nest stubs, and a smaller area around the nest stub itself. Breeding territories of downies in Illinois ranged from 0.5 to 1.2 ha (1.3 to 3.1 acres) (Calef 1953 cited by Graber et al. 1977). Male and female downy woodpeckers retain about the same breeding season territory from year to year, while their larger overall range has more flexible borders (Lawrence 1966).

Downy woodpeckers occupy all portions of their North American breeding range during the winter (Plaza 1978). There is, however, a slight, local southward migration in many areas.

Special Considerations

Conner and Crawford (1974) reported that logging debris in regenerating stands (1-year old) following clear cutting were heavily used by downy woodpeckers as foraging substrate. Timber harvest operations that leave snags and trees with heart rot standing during regeneration cuts and subsequent thinnings will help maintain maximum densities of downy woodpeckers (Conner et al. 1975). Foraging habitat for the downy woodpecker in Virginia would probably be provided by timber rotations of 60 to 80 years (Conner 1980).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for the entire range of the downy woodpecker.

Season. This model was developed to evaluate the year-round habitat needs of the downy woodpecker.

Cover types. This model was developed to evaluate habitat in Deciduous Forest (DF), Evergreen Forest (EF), Deciduous Forested Wetland (DFW), and Evergreen Forested Wetland (EFW) areas (terminology follows that of U.S. Fish and Wildlife Service 1981).

Minimum habitat area. Minimum habitat area is defined as the minimum amount of contiguous habitat that is required before a species will live and reproduce in an area. Specific information on minimum habitat areas for downy woodpeckers was not found in the literature. However, based on reported territory and range sizes, it is assumed that a minimum of 4 ha (10 acres) of potentially useable habitat must exist or the HSI will equal zero.

Verification level. Previous drafts of this model were reviewed by Richard Conner and Lawrence Kilham and their comments were incorporated into the current draft (Conner, pers. comm.; Kilham, pers. comm.).

Model Description

Overview. This model considers the ability of the habitat to meet the food and reproductive needs of the downy woodpecker as an indication of overall habitat suitability. Cover needs are assumed to be met by food and reproductive requirements and water is assumed not to be limiting. The food component of this model assesses food quality through measurements of vegetative conditions. The reproductive component of this model assesses the abundance of suitable snags. The relationship between habitat variables, life requisites, cover types, and the HSI for the downy woodpecker is illustrated in Figure 1.

Habitat variable	Life requisite	Cover types	
Basal area	Food	Deciduous forest Evergreen forest Deciduous forested wetland Evergreen forested wetland	HSI
Number of snags > 15 cm dbh/0.4 ha (> 6 inches dbh/1.0 acre)	Reproduction		

Figure 1. Relationships of habitat variables, life requisites, and cover types in the downy woodpecker model.

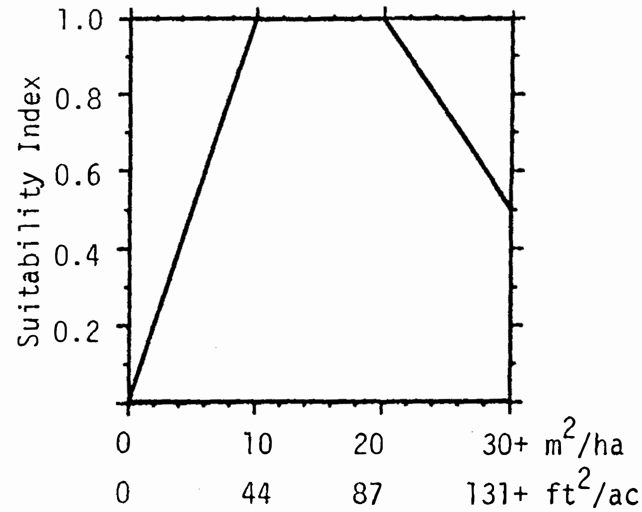
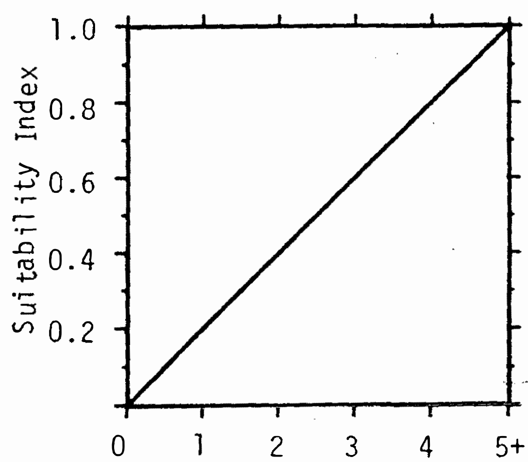
The following sections provide a written documentation of the logic and assumptions used to interpret the habitat information for the downy woodpecker in order to explain the variables and equations that are used in the HSI model. Specifically, these sections cover the following: (1) identification of variables used in the model; (2) definition and justification of the suitability levels of each variable; and (3) description of the assumed relationship between variables.

Food component. Food for the downy woodpecker consists of insects found on trees in forested habitats. Downy woodpeckers occupy a wide variety of forested habitats from virgin bottomlands to sparsely stocked stands along ridges. The highest downy woodpecker densities were most often reported in the more open stands with lower basal areas, but it is assumed that all forested habitats have some food value for downies. Optimal conditions are assumed to occur in stands with basal areas between 10 and 20 m^2/ha (43.6 and 87.2 ft^2/acre), and suitabilities will decrease to zero as basal area approaches zero. Stands with basal areas greater than 30 m^2/ha (130.8 ft^2/acre) are assumed to have moderate value for downy woodpeckers.

Reproduction component. Downy woodpeckers nest in cavities in either totally or partially dead small trees. They require snags greater than 15 cm (6 inches) dbh for nest sites. Optimal habitats are assumed to contain 5 or more snags greater than 15 cm dbh/0.4 ha (6 inches dbh/1.0 acre), and habitats without such snags have no suitability.

Model Relationships

Suitability Index (SI) graphs for habitat variables. This section contains suitability index graphs that illustrate the habitat relationships described in the previous section.

Cover type	Variable		Suitability graph
EF,DF, EFW,DFW	V_1	Basal area.	
EF,DF, EFW,DFW	V_2	Number of snags > 15 cm dbh/0.4 ha (> 6 inches dbh/ 1.0 acre).	

Life requisite values. The life requisite values for the downy woodpecker are presented below.

Life requisite	Cover type	Life requisite value
Food	EF,DF,EFW,DFW	V_1
Reproduction	EF,DF,EFW,DFW	V_2

HSI determination. The HSI for the downy woodpecker is equal to the lowest life requisite value.

Application of the Model

Definitions of variables and suggested field measurement techniques (Hays et al. 1981) are provided in Figure 2.

Variable (definition)		Cover types	Suggested technique
V_1	Basal area [the area of exposed stems of woody vegetation if cut horizontally at 1.4 m (4.5 ft) height, in m^2/ha (ft^2/acre)].	EF,DF,EFW,DFW	Bitterlich method
V_2	Number of snags > 15 cm (6 inches) dbh/0.4 ha (1.0 acre) [the number of standing dead trees or partly dead trees, greater than 15 cm (6 inches) diameter at breast height (1.4 m/4.5 ft), that are at least 1.8 m (6 ft) tall. Trees in which at least 50% of the branches have fallen, or are present but no longer bear foliage, are to be considered snags].	EF,DF,EFW,DFW	Quadrat

Figure 2. Definitions of variables and suggested measurement techniques.

SOURCES OF OTHER MODELS

Conner and Adkisson (1976) have developed a discriminant function model for the downy woodpecker that can be used to separate habitats that possibly provide nesting habitat from those that do not provide nesting habitat. The model assesses basal area, number of stems, and canopy height of trees.

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15. Supplementary Notes

16. Abstract (Limit: 200 words)

A review and synthesis of existing information was used to develop a habitat model for the downy woodpecker (Picoides pubescens). The model is scaled to produce an index of habitat suitability between 0 (unsuitable habitat) and 1 (optimally suitable habitat) for areas of the continental United States. Habitat suitability indexes are designed for use with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

17. Document Analysis a. Descriptors

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b. Identifiers/Open-Ended Terms

Downy woodpecker
Picoides pubescens
Habitat Suitability Indexes (HSI)

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
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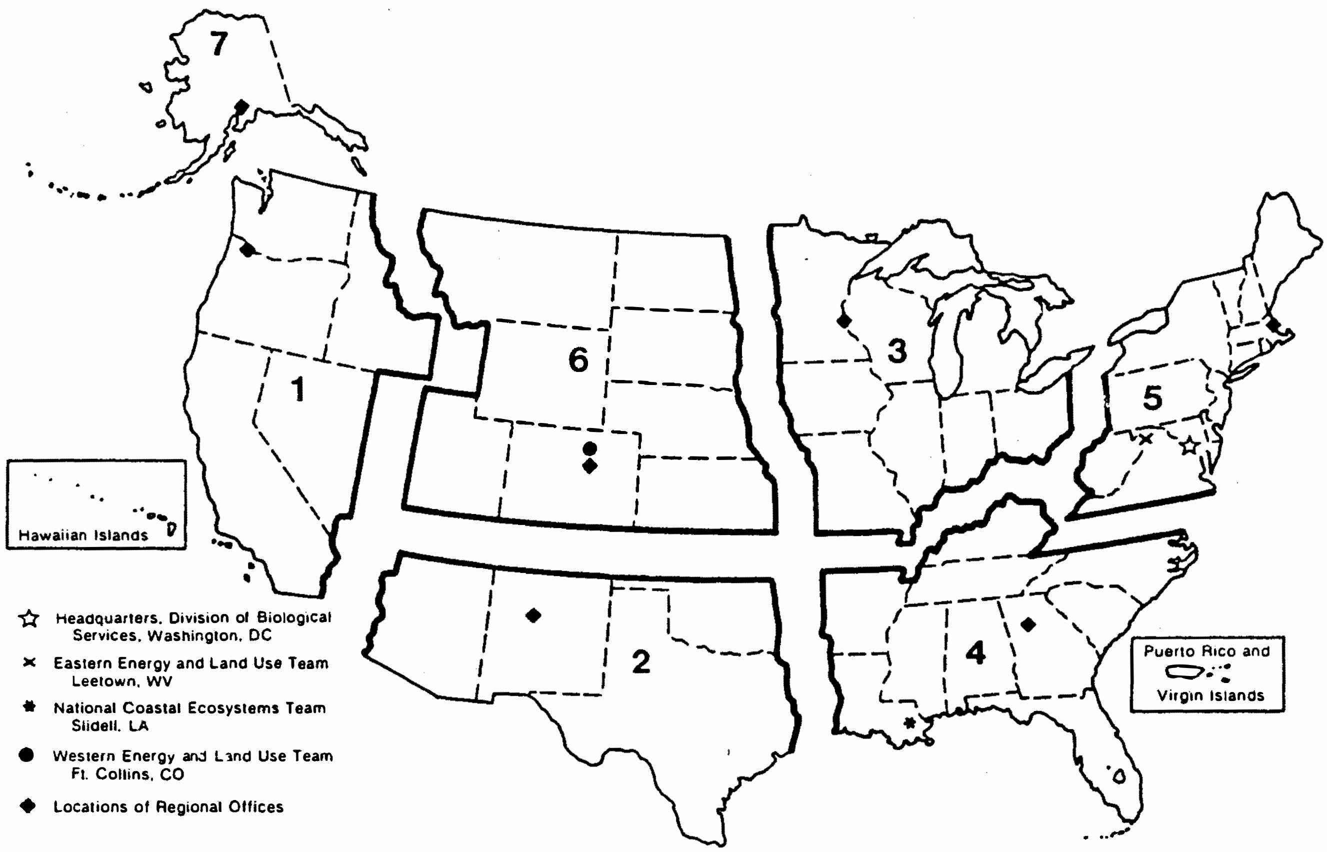

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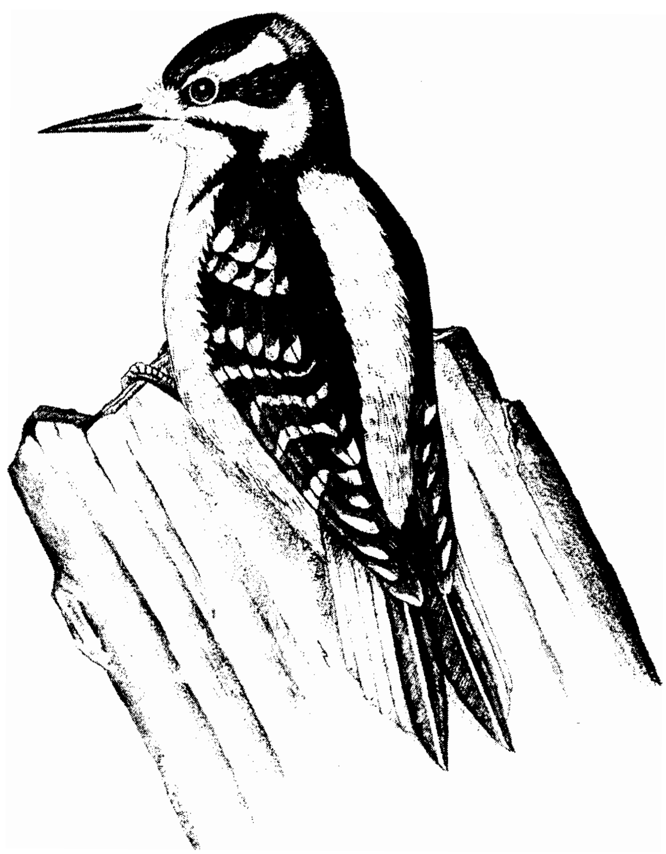
BIOLOGICAL REPORT 82(10.146)
SEPTEMBER 1987

HABITAT SUITABILITY INDEX MODELS: HAIRY WOODPECKER



Fish and Wildlife Service

U.S. Department of the Interior

MODEL EVALUATION FORM

Habitat models are designed for a wide variety of planning applications where habitat information is an important consideration in the decision process. However, it is impossible to develop a model that performs equally well in all situations. Assistance from users and researchers is an important part of the model improvement process. Each model is published individually to facilitate updating and reprinting as new information becomes available. User feedback on model performance will assist in improving habitat models for future applications. Please complete this form following application or review of the model. Feel free to include additional information that may be of use to either a model developer or model user. We also would appreciate information on model testing, modification, and application, as well as copies of modified models or test results. Please return this form to:

Habitat Evaluation Procedures Group
U.S. Fish and Wildlife Service
2627 Redwing Road, Creekside One
Fort Collins, CO 80526-2899

Thank you for your assistance.

Species ______________ Geographic Location ____________________________________

Habitat or Cover Type(s) ____

Type of Application: Impact Analysis ____ Management Action Analysis _____
Baseline _____ Other ____

Variables Measured or Evaluated ____
____
____
____

Was the species information useful and accurate? Yes ____ No ____

If not, what corrections or improvements are needed?_________________________
____
____
____

Were the variables and curves clearly defined and useful? Yes ____ No ____

If not, how were or could they be improved? ______________________________

____

____

____

Were the techniques suggested for collection of field data:

Appropriate? Yes ____ No ____

Clearly defined? Yes ____ No ____

Easily applied? Yes ____ No ____

If not, what other data collection techniques are needed? ______________

____

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____

Were the model equations logical? Yes ____ No ____

Appropriate? Yes ____ No ____

How were or could they be improved? ____________________________________

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____

Other suggestions for modification or improvement (attach curves, equations, graphs, or other appropriate information) ____________________

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Additional references or information that should be included in the model:

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Model Evaluator or Reviewer ___________________________ Date _______________

Agency ____

Address ____

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Telephone Number Comm: _________________________ FTS ___________________

Biological Report 82(10.146)
September 1987

HABITAT SUITABILITY INDEX MODELS: HAIRY WOODPECKER

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PREFACE

This document is part of the Habitat Suitability Index (HSI) model series [Biological Report 82(10)], which provides habitat information useful for impact assessment and habitat management. Several types of habitat information are provided. The Habitat Use Information section is largely constrained to those data that can be used to derive quantitative relationships between key environmental variables and habitat suitability. This information provides the foundation for the HSI model and may be useful in the development of other models more appropriate to specific assessment or evaluation needs.

The HSI Model section documents the habitat model and includes information pertinent to its application. The model synthesizes the habitat use information into a framework appropriate for field application and is scaled to produce an index value between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). The HSI Model section includes information about the geographic range and seasonal application of the model, its current verification status, and a list of the model variables with recommended measurement techniques for each variable.

The model is a formalized synthesis of biological and habitat information published in the scientific literature and may include unpublished information reflecting the opinions of identified experts. Habitat information about wildlife species frequently is represented by scattered data sets collected during different seasons and years and from different sites throughout the range of a species. The model presents this broad data base in a formal, logical, and simplified manner. The assumptions necessary for organizing and synthesizing the species-habitat information into the model are discussed. The model should be regarded as a hypothesis of species-habitat relationships and not as a statement of proven cause and effect relationships. The model may have merit in planning wildlife habitat research studies about a species, as well as in providing an estimate of the relative suitability of habitat for that species. User feedback concerning model improvements and other suggestions that may increase the utility and effectiveness of this habitat-based approach to fish and wildlife planning are encouraged. Please send suggestions to:

Resource Evaluation and Modeling Section
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CONTENTS

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A field validation of an earlier version of the HSI model for the hairy woodpecker was conducted under the direction of Ms. L. Jean O'Neil, U.S. Army Corps of Engineers, Waterways Experiment Station, Vicksburg, MS. The field validation was based on habitat evaluation by the following individuals:

Dr. F.J. Alsop, III, East Tennessee State University, Johnson City

Dr. C.E. Bock, University of Colorado, Boulder

Dr. R.N. Conner, U.S. Forest Service, Nacogdoches, TX

Dr. J.A. Jackson, Box Z, Mississippi State, MS

Dr. F.C. James, Florida State University, Tallahassee

Dr. B.J. Schardien Jackson, Mississippi State, MS

Mr. J. Teaford and Dr. T. Roberts, Waterways Experiment Station, and Dr. J. Wakeley, Pennsylvania State University, assisted in the study design, data collection, data analysis, and model modification. The field validation resulted in several improvements in the model. The efforts of all of those involved in the field validation are very much appreciated.

Earlier drafts of the model were reviewed by Dr. R.N. Conner and Dr. C.E. Bock. Their review comments led to significant improvements in the model and are appreciated.

Word processing of this document was provided by C. Gulzow, D. Ibarra, P. Gillis, and E. Barstow. The cover was illustrated by J. Shoemaker.

HAIRY WOODPECKER (Picoides villosus)

HABITAT USE INFORMATION

General

The hairy woodpecker (Picoides villosus) breeds and winters throughout most of North America (American Ornithologists' Union 1983). The species is a primary cavity nester in "deciduous or coniferous forest, well-wooded towns and parks, and open situations with scattered trees ..." (American Ornithologists' Union 1983:391).

Food

Animal matter, such as beetle larvae (Coleoptera), ants (Hymenoptera), caterpillars (Lepidoptera), and adult beetles, accounted for 78% of the hairy woodpecker's annual diet, based on 382 stomachs collected throughout North America (Beal 1911). The diet is supplemented by fruit and mast (Beal 1911; Hardin and Evans 1977). Hairy woodpeckers forage extensively for seeds in winter (Jackman 1975); in Colorado, they foraged extensively during the non-reproductive season on the seeds of ponderosa pine (Pinus ponderosa) (Stallcup 1966). Hairy woodpeckers may concentrate in areas of insect outbreaks in response to the increased food source (Koplin 1967; Massey and Wygant 1973). The hairy woodpecker was considered to be a primary predator of the Southern pine beetle (Dendroctonus frontalis) in east Texas (Kroll and Fleet 1979).

Hairy woodpeckers are considered opportunistic foragers (Raphael and White 1984); they forage on a variety of substrates, including tree trunks, stumps, exposed roots (Lawrence 1966), snags, downed logs, the ground (Mannan et al. 1980), and logging debris in recent clearcuts (Conner and Crawford 1974). In California, hairy woodpeckers foraged on snags 51% of the time and on live trees 47% of the time (Raphael and White 1984). During winter, hairy woodpeckers in Virginia foraged most often on dead trees or dead parts of live trees (Conner 1980). Hairy woodpeckers in New York exhibited a sexual difference in the selection of winter foraging sites; males foraged on dead trees significantly more often than females, and females foraged significantly more often on live trees (Kisiel 1972). Both sexes used a variety of tree species for foraging sites. A variety of tree species was also used for foraging by hairy woodpeckers in Sierra Nevada forests (Raphael and White 1984). Snags used for foraging in Douglas-fir (Pseudotsuga menziesii) forests in Oregon averaged 61 cm dbh and ranged from 13 to 173 cm dbh (Mannan 1977). The average foraging height of hairy woodpeckers in Iowa was 8.8±1.55 m, and the average diameter of limbs used for foraging was 6.52±1.04 cm (Gamboa and Brown 1976). Hairy woodpeckers in New York typically foraged on limbs 5 to 10 cm in diameter (Kisiel 1972).

Hairy woodpeckers in southwestern Virginia foraged in "... habitats with relatively dense vegetation near the ground" (Conner 1980:121) in comparison to foraging habitat selected by other species of woodpeckers, especially the downy woodpecker (P. pubescens).

Water

No specific information on water requirements of the hairy woodpecker was found in the literature.

Cover

Hairy woodpeckers inhabit a wide variety of forest cover types. For example, they inhabit Douglas-fir forests (Mannan et al. 1980), ponderosa pine forests (Diem and Zeveloff 1980), pinyon-juniper (Pinus edulis - Juniperus spp.) woodlands (Balda and Masters 1980), eastern deciduous forests (Conner et al. 1975), and riparian communities (Stauffer and Best 1980). Winter population densities of hairy woodpeckers in Illinois were positively correlated with the number of trees >56 cm dbh and with a diversity of genera and species of large trees (Graber et al. 1977). Hairy woodpeckers in Oregon use the shrub/sapling (8 to 15 yr) and second-growth (16 to 40 yr) stages of Douglas-fir forests, but they do not nest in these younger stages (Meslow and Wight 1975). Jackman (1975) stated that hairy woodpeckers inhabit second-growth, partially thinned, and other altered forest types; however, hairy woodpeckers were reported more frequently (95% of 40 breeding bird censuses) in mature undisturbed habitats in the northern hardwoods region than in disturbed and successional habitats (43% of 30 censuses) (Noon et al. 1979).

Hairy woodpeckers use tree cavities for roosting and winter cover, as well as for nesting and rearing young (Thomas et al. 1979), and they will excavate new cavities in the fall to be used for roosting (Jackman 1975).

Reproduction

The hairy woodpecker is a primary cavity nester that is able to adapt to a wide variety of habitats (Kilham 1968). In the Pacific Northwest, hairy woodpeckers require standing dead trees and live trees with rotted heartwood (Jackman 1975). Similarly, hairy woodpeckers in Virginia exhibited a definite preference for trees with heartrot (Conner et al. 1975; Conner et al. 1976). Thomas et al. (1979), however, listed the hairy woodpecker as a species that usually excavates in sound wood. Runde and Capen (1987) found that the amount of sound wood varied widely (based on a visual estimate) in live trees used for nesting by hairy woodpeckers; 11 of 21 nests were in live trees. A possible exception to the apparently general use of live or dead trees for nest sites is that hairy woodpeckers do not nest in Engelmann spruce (Picea engelmannii) forests in the Pacific Northwest (Jackman 1975). Haapanen (1965 cited by Smith 1980:264) found that "of all the woodpeckers found in spruce-fir forests, apparently only the Northern 3-toed Woodpecker [Picoides tridactylus] is capable of making holes in the dense wood of living spruce trees." R.N. Conner (U.S. Forest Service, Nacogdoches, TX; letter dated February 19, 1986) suggests, however, that Engelmann spruce and other North American spruces are relatively soft-wooded trees (compared to oaks) that can be easily excavated by some species of woodpeckers. He suggests that the lack of use may be due to the absence of heartwood decay or to resin produced by spruce rather than to the density of the spruce wood. Whatever the reason for the observed lack of use, Conner believes that insufficient data exist to categorically classify live spruces as unsuitable for excavation by hairy woodpeckers.

Preferred nesting areas of hairy woodpeckers in east Tennessee were characterized by a large number of trees >23 cm dbh and associated high canopy biomass (Anderson and Shugart 1974). Hairy woodpeckers in Virginia apparently preferred areas with high stem density, but nested in areas with a wide range of basal areas, canopy heights, stem densities, and distances from cleared areas (Conner and Adkisson 1977). In northwestern Washington, hairy woodpecker nests were found in a variety of successional stages, though most were in, or at the edge of, old-growth forests (Zarnowitz and Manuwal 1985). Hairy woodpeckers in Washington are found in open rather than dense stands of timber (Larrison and Sonnenberg 1968), and in California's Sierra Nevada they prefer forests of low to moderate canopy closure (<70%) (Verner 1980). Both understocked and fully stocked stands in Virginia were suitable nesting areas as long as decayed trees were present (Conner et al. 1975). Hairy woodpeckers have even been reported nesting in the grass-forb stage of mixed coniferous forest regeneration by using stumps <1.5 m tall (Verner 1980).

Hairy woodpeckers require trees with a minimum dbh of 25 cm and a minimum height of 4.6 m for nesting (Thomas et al. 1979). Raphael and White (1984:24) found that "...diameter was the tree characteristic most closely correlated with nesting use" for 17 cavity-nesting birds. Conner and Adkisson (1976) found that canopy height had a greater influence on distinguishing between "possible nesting habitat" and "not nesting habitat" than did either basal area or stem density. In Vermont, no significant difference in mean tree height was detected between nest trees and adjacent non-nest trees (Runde and Capen 1987). Diameter at breast height (dbh) and diameter at nest height (dnh) were significantly greater for nest trees than non-nest trees ($\bar{x}$ dbh:27.1±1.3 cm vs. 23.9±0.7 cm, $P<0.05$; $\bar{x}$ dnh:22.4±1.1 cm vs. 13.2±9.6 cm, $P<0.01$). The probable optimum diameter range for hairy woodpecker nest trees is 25 to 35 cm dbh, and the probable optimum height range for nest trees is 6 to 12 m (Evans and Conner 1979). In Douglas-fir forests, however, hairy woodpeckers nest in older second-growth (41 to 120 yr) and mature (120+ yr) forests (Meslow and Wight 1975); these age classes are presumably taller than the optimum range suggested by Evans and Conner (1979). The average height of eight trees used for nesting in a Colorado aspen forest was 18 m, and ranged from about 11 to 21.3 m (Scott et al. 1980). Ten trees used for nesting in Virginia averaged 13.0 m tall and ranged from 4 to 26.5 m (Conner et al. 1975). The diameter of the tree at the cavity level in these 10 trees averaged 25.2 cm and ranged from 20 to 46 cm. In California, 19 nest trees averaged 13.7 m tall with an average diameter at the cavity level of 36.3±2.09 cm (Raphael and White 1984). Table 1 summarizes tree condition, nest heights, and nest tree diameter from several studies.

Table 1. Characteristics of nest sites selected by hairy woodpeckers in several study areas.

Source	Number of nests (n)	Tree condition: Dead	Tree condition: Live	Average nest height (range)	Average nest tree dbh (range)
Lawrence (1966) (NH)	11 (n=7 for dbh)	1	10	10.5 m (4.5-14 m) 34.9 ft (15-45 ft)	28 cm (25.4-34.8 cm) 11.1 inches (10-13.7 inches)
Conner et al. (1975) (VA)	10	5	5[a]	8.8 m (2.4-19.8 m) 28.9 ft (7.9-65 ft)	40.6 cm (20-64 cm) 16 inches (7.9-25.2 inches)
Jackman (1975) (OR)	33	?	?	7.6 m (5-10 m) 24.9 ft (16.4-32.8 ft)	?
Graber et al. (1977) (IL)	17	6	11[b]	4.6-10.7 m 15-35 ft	?
Mannan (1977) (OR)	7	?	?	18.2 m (7.9-41.8 m) 59.4 ft (25.9-137.1 ft)	92 cm (48-172 cm) 36.2 inches (18.9-67.8 inches)
Scott et al. (1980) (CO)	8	2	6	10 m (6.7-15.2 m) 33 ft (22-50 ft)	38 cm (25.4-58.4 cm) 15 inches (10-23 inches)
Raphael and White (1984) (CA)	19	16	3[c]	4.9±0.69 m 16.1±2.26 ft	43.8 cm 17.2 inches
Zarnowitz and Manuwal (1985) (WA)	16	16[d]	-	13±12 m 42.6±39.4 ft	41±13 cm 16.1±5.1 inches
Runde and Capen (1987) (VT)	21	10	11[e]	17.5±1.2 m 57.4±3.9 ft	27.1±1.3 cm 10.7±0.5 inches

[a] Four of the five nests in live trees were located in dead portions of the trees; the fifth was located in a totally live oak tree with a decayed heartwood (Conner, unpubl.).

[b] About one-half of these nests were located in dead portions of the trees.

[c] Located in dead portions of live trees.

[d] All nests located in broken-top trees.

[e] All 11 cavities were drilled through live wood.

Hairy woodpeckers will excavate in both hard and soft snags (Evans and Conner 1979); however, hairy woodpecker breeding densities were significantly positively correlated ($P \leq 0.01$) with soft snags in Iowa riparian forests (Stauffer and Best 1980). The hairy woodpecker was categorized as a soft snag excavator in Sierra Nevada forests (Raphael and White 1984). Evans and Conner (1979) estimated that 200 snags were necessary in order to support the maximum population of hairy woodpeckers on 40 ha of forest. Their estimate was based on a minimum annual need of four cavities per pair, and an assumption that only 10% of the available snags would be suitable for use. Snag density requirements decreased in direct proportion to the percentage of maximum population desired; e.g., 160 snags are required to support 80% of the maximum population, and 100 snags would support 50% of the maximum population. A similar estimate for the Blue Mountains of Oregon and Washington was that 180 snags/40 ha are necessary to support maximum populations of hairy woodpeckers (Thomas et al. 1979). Raphael and White (1984) distinguished between hard and soft snags in estimating the density of snags required to support the maximum density of hairy woodpeckers. They assumed a maximum density of 16 pairs/40 ha, an annual rate of excavation of 4 cavities/pair, and a reserve of 3 suitable cavities per pair to arrive at an estimate of 192 suitable snags/40 ha to support the maximum density. They further estimated that 4 hard snags are required to produce 1 soft snag, resulting in an estimate of 768 "hard snag equivalents" (Raphael and White 1984:56) per 40 ha. Although low numbers of snags can, in theory, support low-density woodpecker populations, enough snags to support 40% of the maximum population was assumed to be the minimum that will support a self-sustaining population of hairy woodpeckers in the Pacific Northwest (Bull 1978).

Interspersion and Composition

Territory size in a mature bottomland forest in Illinois averaged 1.1 ha and ranged from 0.6 to 1.5 ha (Calef 1953 cited by Graber et al. 1977). Reported territory size of hairy woodpeckers in the Blue Mountains of Washington and Oregon averaged 2.4 to 3.6 ha (Thomas et al. 1979). Evans and Conner (1979), however, reported an average territory size of 8 ha based on available literature, whereas territories reported for two hairy woodpeckers in Kansas were 9 and 15 ha (Fitch 1958). Home range and territory size are strongly influenced by habitat quality and, therefore, can be quite variable (Conner, unpubl.).

In a study of bird use of various sized forested habitats in New Jersey, hairy woodpeckers did not occur in areas of <2 ha (Galli et al. 1976). A minimum width of riparian forest necessary to support breeding populations of hairy woodpeckers in Iowa was 40 m (Stauffer and Best 1980). Robbins (1979) compared frequency of occurrence of hairy woodpeckers at Breeding Bird Survey stops in Maryland to the amount of contiguous forested area. The greatest decrease in frequency of occurrence was recorded at 4 ha of contiguous forested habitat, and Robbins (1979) proposed this value as a preliminary estimate of the minimum area necessary to support a viable breeding population of hairy woodpeckers. Conner (unpubl.), however, believes that 4 ha may represent the minimal area that hairy woodpeckers will use, but that such a small area could not support a viable breeding population, which he considers to be a minimum of 250 pairs. He suggested a minimum habitat area of 12 ha to support several breeding pairs of hairy woodpeckers (R.N. Conner, U.S. Forest Service, Nacogdoches, TX; letter dated December 1, 1981).

Although the hairy woodpecker is considered a resident species throughout its range, altitudinal migrations between mountainous areas and lower elevations do occur (Bailey and Niedrach 1965).

Special Considerations

The hairy woodpecker has been classed as a "tolerant species" to habitat alteration in Iowa (Stauffer and Best 1980), but also has been suggested as a sensitive environmental indicator of the ponderosa pine community (Diem and Zeveloff 1980).

HABITAT SUITABILITY INDEX (HSI) MODEL

Model Applicability

Geographic area. This model was developed for application within forested habitat throughout the entire range of the hairy woodpecker. Use of the model differs, however, between forests in the eastern United States and the western United States. The differences in application are described in the model.

Season. This model was developed to evaluate the year-round habitat of the hairy woodpecker.

Cover types. This model was developed to evaluate habitat in the following forested cover types: Deciduous Forest (DF), Evergreen Forest (EF), Deciduous Forested Wetland (DFW), and Evergreen Forested Wetland (EFW) (terminology follows U.S. Fish and Wildlife Service 1981).

Minimum habitat area. A minimum of 4 ha of forested habitat has been estimated to be necessary to support a viable breeding population of hairy woodpeckers (Robbins 1979), although Conner (unpubl.) believes that such a small area may represent the minimum needed to support one pair rather than a viable breeding population. Conner (unpubl.) suggested 12 ha as a reasonable estimate of the area needed to support several pairs of hairy woodpeckers. Additionally, forested riparian zones should be at least 40 m wide to be considered as potential breeding habitat for hairy woodpeckers (Stauffer and Best 1980).

Verification level. An earlier draft of the HSI model for the hairy woodpecker was used in a field evaluation of model outputs compared to expert opinion (O'Neil et al. 1988). The following species experts participated in the field evaluation:

Dr. F.J. Alsop, III, East Tennessee State University, Johnson City

Dr. C.E. Bock, University of Colorado, Boulder

Dr. R.N. Conner, U.S. Forest Service, Nacogdoches, TX

Dr. J.A. Jackson, Box Z, Mississippi State, MS

Dr. F.C. James, Florida State University, Tallahassee

Dr. B.J. Schardien Jackson, Mississippi State, MS

Initial results indicated that outputs from the earlier model were poorly correlated ($r=0.07$, $P>0.50$) with habitat ratings by experts for 40 sites in eastern Tennessee (O'Neil et al. 1988). Important habitat criteria identified by the experts were used to modify the model in an attempt to more closely mimic the procedures used by experts to rate habitats. The major changes to the model as a result of the field evaluation were (1) optimum suitability for the average diameter of overstory trees was changed from 25 to 38 cm; (2) snags were assigned greater importance than live trees for nesting; (3) the variable "percent canopy cover of pines" was added to reflect a strong negative correlation ($r=-0.91$, $P<0.001$) between this variable and habitat ratings by species authorities; (4) the mathematical function used to calculate the cover suitability index was changed from a geometric mean to a multiplicative function; and (5) the suitability relationship for tree canopy closure was changed from a preference for moderate canopy closure to a preference for dense forest canopy. Correlation of outputs from the modified model to habitat ratings by species authorities improved considerably ($r=0.82$, $P<0.001$) (O'Neil et al. 1988).

All of the changes to the model as a result of the field evaluation were based on input from species experts and reflect hairy woodpecker ecology in forests in the eastern United States. The variable "percent canopy cover of pines" is not recommended as an appropriate variable in western forests; use of the model in western vs. eastern forests is described below. The current model is the direct result of the field evaluation; it has not been field tested.

Model Description

Overview. The hairy woodpecker can satisfy all of its habitat requirements within any one of the forested cover types listed above. Reproductive and cover needs are evaluated in this model. Although sufficient food is an obvious life requisite of the hairy woodpecker, I assume in this model that food will never be more limiting than cover and reproductive requirements and that water is not a limiting factor.

The following sections identify important habitat variables, describe suitability levels of the variables, and describe the relationships between variables.

Reproduction component. The hairy woodpecker is able to adapt to a variety of habitats, but suitable reproductive habitats must (1) be dominated by trees of sufficient size and decay for nesting, (2) have adequate snag densities, or (3) have some combination of the two.

The number of snags ≥25.4 cm dbh necessary to support maximum densities of hairy woodpeckers has been estimated to range from 180/40 ha (Thomas et al. 1979) to 200/40 ha (Evans and Conner 1979), or 4.5 to 5 snags/ha; a snag density of 5/ha is assumed to represent optimal conditions for reproduction (Figure 1a). This estimate refers specifically to nesting and roosting requirements and may not adequately satisfy foraging needs (Conner, unpubl.). Potential population density is assumed to decrease proportionally with a decrease in snag density. Although I assume in this model that low snag densities will support low woodpecker densities, Bull (1978) assumed that snag densities <40% of those needed for maximum population density would not support a self-sustaining population.

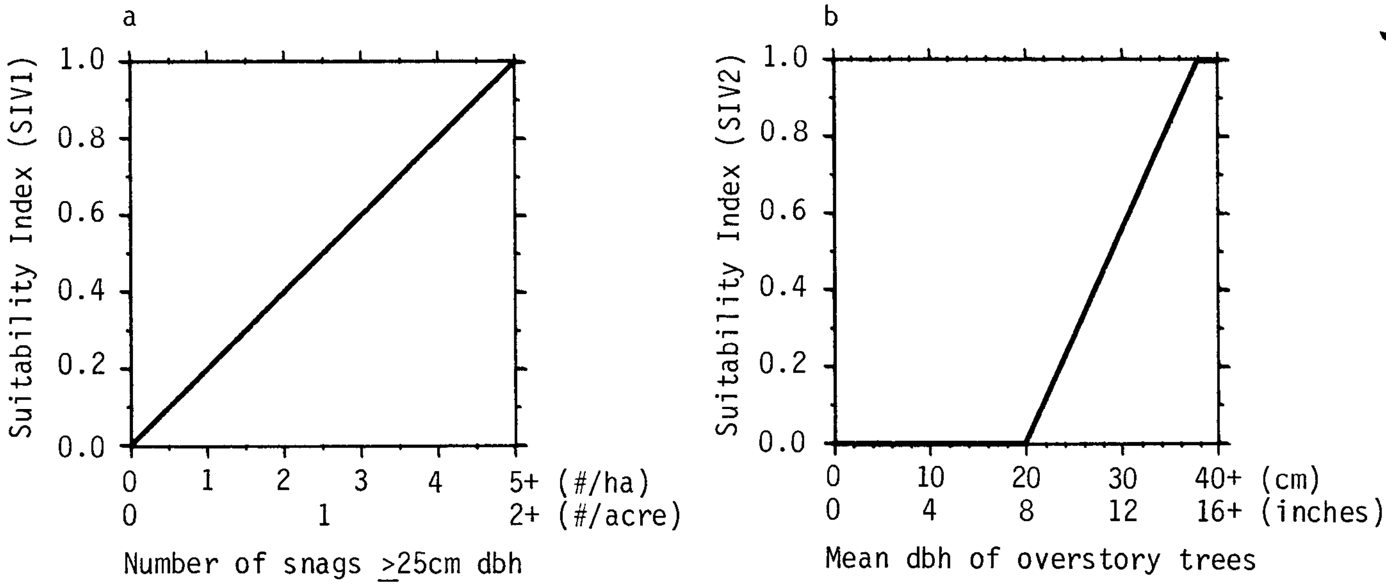

Figure 1. Relationships between variables used to evaluate reproductive habitat for the hairy woodpecker and suitability levels for the variables.

Hairy woodpeckers can excavate cavities in live trees provided that heartrot is present, and thus may inhabit a forested area even in the absence of snags. Runde and Capen (1987) believed that trees >30 cm dbh would be most useful to hairy woodpeckers, downy woodpeckers, and yellow-bellied sapsuckers (Syphrapicus varius). For this model, I assume that if the average dbh of overstory trees is ≥38 cm, then trees will be of optimum size for nesting. I assume that an adequate number of available (i.e., with heartrot) live trees will be present if the average dbh of overstory trees is ≥38 cm. There is little evidence correlating tree diameter and presence of heartrot, but the alternative is to physically examine trees for heartrot; this level of detail is presumed to be too great for the typical application of this model. Use of the average dbh of overstory trees does not consider the absolute number of available live trees. I assume that if an area meets the minimum requirements to be classified as a forest and is >4 ha, then the total number of trees available for potential nesting will be optimal. Assuming that adequate numbers of trees are present, the size and condition of the trees will determine whether the nesting potential will be low or high. The minimum reported dbh of a tree used for nesting by hairy woodpeckers is 20.1 cm (Conner et al. 1975). Thus, I assume that optimal conditions for this variable exist when the average dbh of overstory trees is ≥38 cm, and that conditions are unsuitable when the average dbh of overstory trees is ≤20 cm (Figure 1b). The values defining optimum and suitable levels of this variable are based on results of the field test mentioned earlier.

Overall nesting suitability is a function of the availability of snags or live trees. In the field test, experts consistently rated habitats without snags lower than habitats with snags (O'Neil et al. 1988), presumably because hairy woodpeckers cannot excavate in undecayed trees and prefer to forage on dead snags (Conner, unpubl.). Habitat suitability ratings in habitats without snags that were otherwise suitable were generally between 0.7 and 0.8 (on a 0-1 scale). I assume, therefore, that habitats without snags (i.e., all potential nest sites are in live trees) will have a maximum suitability rating of 0.75. An overall suitability index for nesting (SIN), based on the relationships described above, can be determined with Equation 1.

$$SIN = SIV1 + (0.75 \times SIV2) \qquad (1)$$

[Note: If the value resulting from Equation 1 exceeds 1.0, it should be set to 1.0.]

Cover component. Besides having sufficient potential nest sites, at least three other habitat factors affect the overall suitability of a habitat for hairy woodpeckers. These three factors are the seral stage of a forest stand, the degree of canopy cover of the forest, and the proportion of pines in the canopy. These variables are assumed to influence food availability, foraging, nesting suitability, and cover, but are aggregated into a cover component in this model. Because these factors affect overall habitat suitability, they will be used in this model as modifiers of the reproductive value.

A measure of the seral stage of a forest is the average diameter of the overstory trees. Hairy woodpeckers may inhabit young forests, but at lower densities than in older forests. Because they do inhabit forests in a variety of seral stages, however, this habitat variable should not be strictly limiting. I assume in this model that the optimal seral stage exists when the average dbh of overstory trees is >25 cm (Figure 2a). When the average dbh of overstory trees is <15 cm, suitability is assumed to be one-half of optimum, i.e., a suitability index of 0.5.

The literature suggests that hairy woodpeckers apparently prefer forests of moderate canopy cover. Habitat ratings by species experts in the field test, however, tended to be higher in forest stands with a dense canopy, except that closed canopy stands were generally rated lower than stands with <100% canopy cover (O'Neil et al. 1988). I assume that optimal conditions for this variable occur at 85% to 90% (Figure 2b) with complete canopy cover representing less than optimal habitat. I further assume that canopy cover <15% will provide unsuitable habitat conditions. Since the definition of a forest is a cover type with at least 25% tree canopy cover, any forest will have canopy conditions of some positive suitability level for hairy woodpeckers.

Hairy woodpeckers inhabit a variety of deciduous, coniferous, and mixed deciduous-coniferous habitats. Habitat ratings by experts were negatively correlated ($r=-0.91$, $P<0.001$) with the percent canopy closure of pines; sites completely dominated by pines received relatively low habitat ratings (O'Neil et al. 1988). I assume in this model that an increase in the canopy cover of pines in a stand will generally reflect a decrease in habitat suitability for the hairy woodpecker, although a small amount of pines (≤10% canopy cover) is assumed to contribute to the diversity of cover and prey (Figure 2c). Sites completely dominated by pines are assumed to have a suitability index for this variable of 0.2. The apparent influence of pines on hairy woodpecker habitat suitability described above probably does not apply in western coniferous forests (C.E. Bock, Environmental, Population and Organismic Biology, University of Colorado, Boulder; letter dated February 24, 1986). I recommend that the variable "percent canopy cover of pines" be deleted from the model for application in western coniferous forests. It is unclear whether a similar negative relationship exists between other species of conifers in eastern forests and perceived habitat suitability for the hairy woodpecker.

Results from the field test of the earlier model indicated that the product of the suitability indices (Equation 2) for the cover component variables most closely reflected habitat ratings by species experts (O'Neil et al. 1988).

$$SIC = SIV3 \times SIV4 \times SIV5 \tag{2}$$

As long as an area is classified as a forested type, all of the variables in Equation 2 will be greater than zero, and the index value for the cover component will likewise be greater than zero.

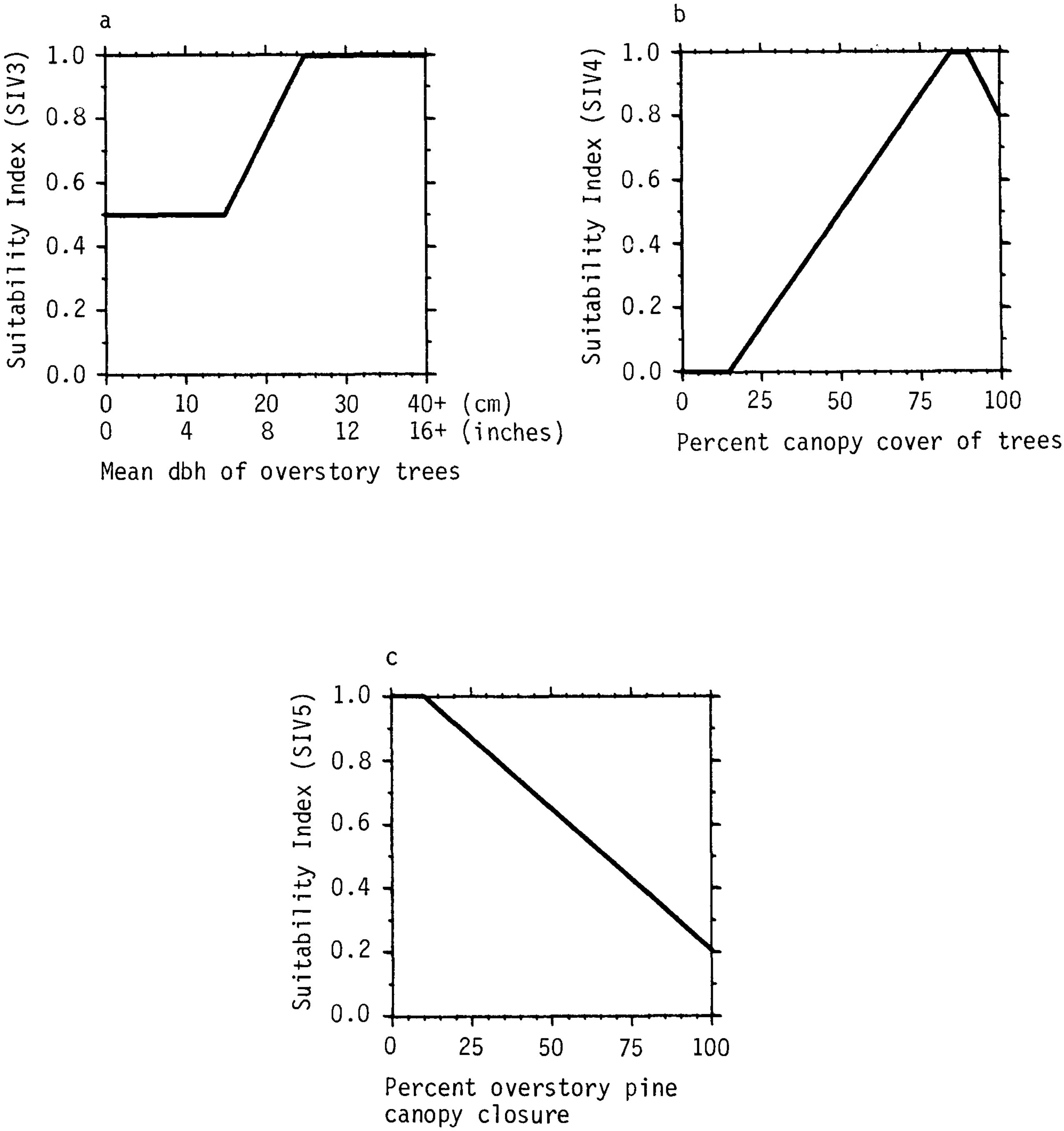

Figure 2. Relationships between variables used to evaluate cover for the hairy woodpecker and suitability levels for the variables.

HSI determination. The suitability index for the cover component is assumed to directly modify the suitability index for the reproduction component (Equation 3) to yield an overall HSI value for the hairy woodpecker in the habitat being evaluated. At optimal cover component conditions (i.e., SIC=1.0), the reproduction component will determine the habitat suitability index. If cover conditions are anything less than optimum, then the reproduction value will be reduced based on the quality of the cover conditions.

$$HSI = SIN \times SIC, \text{ or}$$

$$HSI = [SIV1 + (0.75 \times SIV2)] \times (SIV3 \times SIV4 \times SIV5) \tag{3}$$

[Note: In instances where SIN >1.0, it should be set equal to 1.0 prior to using Equation 3.]

Application of the Model

Summary of model variables. Several habitat variables are used in this model to evaluate habitat suitability for the hairy woodpecker. The relationships between habitat variables, life requisites, cover types, and an HSI are summarized in Figure 3. The definitions and suggested measurement techniques (Hays et al. 1981) for the variables used in this model are listed in Figure 4.

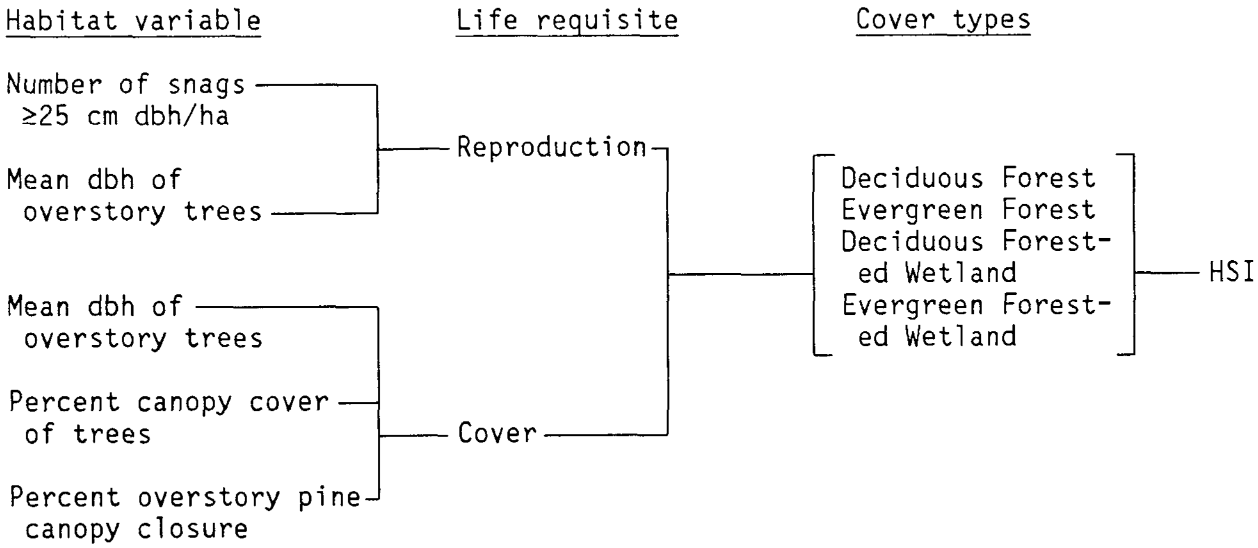

Figure 3. Relationships of habitat variables, life requisites, and cover types to the HSI for the hairy woodpecker.

Variable (definition)	Cover types	Suggested technique
Number of snags ≥25 cm dbh per ha [actual or estimated number of standing dead trees ≥25 cm dbh and ≥1.8 m tall. Trees in which ≥50% of the branches have fallen, or are present but no longer bear foliage, are to be considered snags].	DF,EF,DFW, EFW	Quadrat, remote sensing
Mean dbh of overstory trees [the mean diameter at breast height (1.4 m) above the ground of those trees that are ≥80% of the height of the tallest tree in the stand].	DF,EF,DFW, EFW	Diameter tape
Percent canopy cover of trees [the percent of the ground surface that is shaded by a vertical projection of all woody vegetation >6.0 m tall].	DF,EF,DFW, EFW	Line intercept, remote sensing
Percent overstory pine canopy closure [the percent of the ground surface that is shaded by a vertical projection of all pines (*Pinus* spp.) >6.0 m tall and ≥80% of the height of the tallest tree in the stand; recommended for use in eastern U.S. forests only (see text for explanation)].	DF,EF,DFW, EFW	Line intercept, remote sensing

Figure 4. Definitions of variables and suggested measuring techniques.

Model assumptions. A number of assumptions were made in the development of this HSI model.

1. The criteria identified for evaluation of hairy woodpecker habitat are generally assumed to be appropriate throughout the range of the species. Many of the variables and variable relationships identified in the model resulted from a field test of an earlier HSI model in eastern Tennessee. As a result, the model is probably best suited for application in the southeastern United States. No information is available to indicate the model's applicability to other parts of the United States, except there is adequate information that the presumed negative influence of pines does not apply to western U.S. forests (see number 7 below).

2. Nest sites can be provided by a combination of snags and live trees, but live trees in the absence of snags cannot provide optimal nesting habitat.

3. A measure of the average diameter at breast height of overstory trees is assumed to be an adequate estimator of the suitability of live trees for nesting. An adequate number of trees in suitable condition (i.e., with decayed heartwood) is assumed to be present as long as the cover type is classified as a forest (i.e., has ≥25% canopy cover) and tree diameter is suitable.

4. All tree species are assumed to be available for excavation by hairy woodpeckers. It is possible that some species may not typically have decayed heartwood and, therefore, will be unsuitable for excavation. It is also possible that some tree species will be unsuitable for excavation because of resins or the density of the wood. Little definitive evidence is available, however, to determine whether some tree species are absolutely unsuitable for excavation by hairy woodpeckers.

5. Hairy woodpeckers can inhabit a variety of forested habitats, but potential nesting in live trees will only be provided by older forest stands with large trees.

6. Hairy woodpeckers prefer forest stands with a dense canopy. This assumption may be valid in the southeastern United States but may be invalid in the western United States, where the forest canopy is generally less dense than in the east. The relationships described for percent canopy cover of trees and habitat suitability (Figure 2b) may need to be redefined for use in western forest habitat if the standard of comparison in such applications is intended to be the best regional habitat. Use of the model without modification will yield outputs based on a standard of comparison developed in the southeastern United States.

7. The presence of pines above a minimal level (10%) is considered to be a negative factor in habitat suitability for the hairy woodpecker in this model (Figure 2c). Pine and other coniferous forests in the western United States, however, are regularly used by hairy woodpeckers. I recommend that this variable be eliminated for application in western coniferous forests.

8. The hairy woodpecker breeds and winters throughout most of North America. I assume in this model that the year-round suitability of a habitat is a function of the habitat suitability during both the reproductive and nonreproductive seasons. Model users who wish to evaluate either of the seasons rather than both can simply use the appropriate portion of this model. Users should be aware that model outputs in such instances will refer only to a portion of the year-round needs of the hairy woodpecker.

SOURCES OF OTHER MODELS

Conner and Adkisson (1976) developed a model to distinguish between "possible nesing habitat" and "not nesting habitat" for the hairy woodpecker in oak-hickory forests of southwestern Virginia. Three variables were included in the model: basal area (m^2/ha), canopy height to crown cover (m), and stem density (number/ha). The model includes coefficients for the three variables, an aggregation function, and a linear decision scale. The model was applied to two groups, the first consisting of stands containing hairy woodpecker nests, and the second consisting of six random plots in each of five habitat types; results of the analysis were significant (P=0.02).

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16. Abstract (Limit: 200 words)

A review and synthesis of existing information were used to develop a Habitat Suitability Index (HSI) model for the hairy woodpecker (*Picoides villosus*). The model consolidates habitat use information into a framework appropriate for field application, and is scaled to produce an index between 0.0 (unsuitable habitat) and 1.0 (optimum habitat). HSI models are designed to be used with Habitat Evaluation Procedures previously developed by the U.S. Fish and Wildlife Service.

17. Document Analysis a. Descriptors

Birds
Wildlife
Habitability
Mathematical models

b. Identifiers/Open-Ended Terms

Hairy woodpecker
Picoides villosus
Habitat suitability

c. COSATI Field/Group

18. Availability Statement	19. Security Class (This Report)	21. No. of Pages
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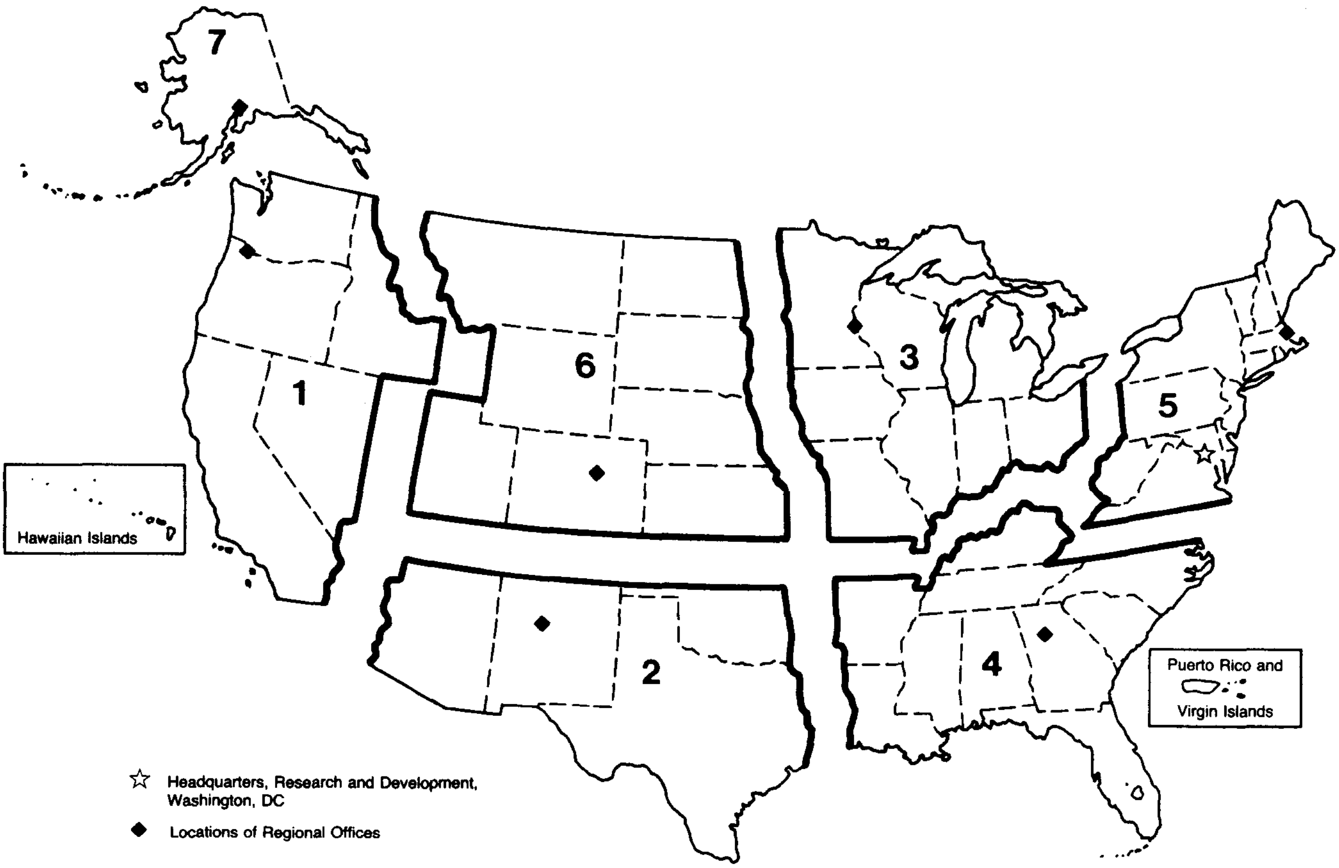

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APPENDIX C: FIELD DATA SHEETS

DATA SHEET TS_30_L HEP P. 21

DATE 12/8/21 TIME 3:15 NAMES Slavesky, Dean

PHOTO# 224-231 WYPT #40-3 end #41-Nend PLOT#/LOCATION #2/end of project

TRANSECT TOTAL LENGTH (FT) 80? / 80? / ____

RSG MODEL: V1 (SHRUB<3M) (FT) 3.0 / 20 / ____

V2 (indiv tree hts. ft) 20 / 18' / 35'/0 / 20' / ____ / ____

V3 (TREE>3M) (FT) 45 / 55 / ____

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 / ____

SNAG (indiv diam. in) 6" (2 pieces ... 5-7' ...)
V5, snag count >4" 1

V6 ALL WOODY 75' / 75' / ____

RECT MODEL: V1 (tree hts. see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 75' / 80' / ____

V3 TREE CANOPY CLOSURE 40' / 50 / ____

V4 # SPECIES (list names) Pecan, VO, Willow, BB ...

V5 UNDERSTORY DENSITY @2FT 80/60/ @6FT 70/50/ ____
@14FT 50/40/ ____ AVERAGE 75/50/ ____

YW MODEL: V1 DECID SHRUB COVER 75' / 60' / ____

V2 SHRUB HTS (ft) T1 2+m almost all ____ ____
(nearest .1M) T2 1.5 - 2+m variable ____

V3 hydrophytic SHRUB COVER 75 / 55' / ____
V4 tall tree 0 / 20'
DW MODEL: V1 SNAG COUNT >6", see above 0

V2 BASAL AREA (cruz-all or see HW, below) ____ / ____ / ____

HW MODEL: V1 SNAG COUNT >10", see above 0
V2/V3 DbH overstory 15 VO 14/8 pecan 11 pecan 21" ... 11" ... 5' pecan
18-9 ... willow ____ ____ ____ ____

V4 CANOPY COVER 10% / 40% / ____
(6mo)

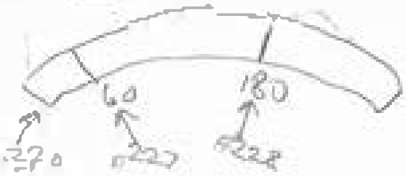
DATA SHEET TS_30_L HEP P. 20

DATE 12/8/21 TIME 1:17pm NAMES Dave F. Steve S.

#226-228 #39 Soil

PHOTO#______ WYPT #40 Need PLOT #/LOCATION #20

TRANSECT TOTAL LENGTH (FT) 80' / 80' / ______



RSG MODEL: V1 (SHRUB<3M) (FT) 20 / 30 / ______

V2 (indiv tree hts, ft) 18 (willow) Pecan 22' 40' (willow) 28 LO 25 VO ______

V3 (TREE>3M) (FT) 25 / 20 / ______

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) (5) / (5) / ______

SNAG (indv diam, in) 4" (6" but 24' off ground) ______
V5, snag count >4" ______

V6 ALL WOODY 45' / 60' / ______

RFCT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 45' / 60' / ______

V3 TREE CANOPY CLOSURE 20% / 10% / ______

V4 # SPECIES (list names) Willow, Willow, [redacted], Pecan, live oak, Valley Oak

V5 UNDERSTORY DENSITY @2FT 50% / 70 / @6FT 35' / 50 /
@14FT 40 / 30 / AVERAGE 45% / 50 ______

Note "%" readings must be 245ft

YW MODEL: V1 DECID SHRUB COVER 40' / 60' / ______

V2 SHRUB HTS (ft) T1 all > 2m+
(nearest .1M) T2 almost all > 2m+ (~1.8M avg)

V3 hydrophylic SHRUB COVER 45' / 60 / ______

V4 Tall tree Ø / Ø

SWMODEL: V1 SNAG COUNT >6", see above ( ) 1 marginal, center Ø

V2 BASAL AREA (cruz-all or see HW, below) ______ / ______ / ______

HW MODEL: V1 SNAG COUNT >10", see above [plot edited, obviously Ø]

V2/V3 DbH overstory 11" (pecan (18, 34, 22, 28, 26, 22) large willow

6" VO 6" pecan 6" LO

V4 CANOPY COVER Ø / 5% / ______

Run 2
Pecan 11"
(18/34/22/28/26/22)
6" VO
6" LO
12" Pecan

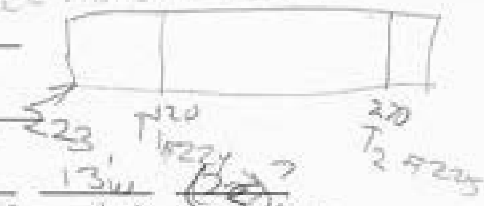
40" large willow thicket
30" large willow thicket

DATA SHEET TS_30_L HEP P. 19

DATE 12/8/21 TIME 11:21am NAMES Steve Sch, Dave F

PHOTO# 223-225 WYPT #38 F-seed #39-Need PLOT#/LOCATION #19

TRANSECT TOTAL LENGTH (FT) 100 / 90 / all herbaceous stole



RSG MODEL: V1 (SHRUB<3M) (FT) 30 / 0 /

V2 (indiv tree hts, ft) 21' @ fig 19' will 15' will 20 18' vo 13' wi 20' will (3) Oaks Valley

V3 (TREE>3M) (FT) ● / 0 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 2 / 1 / /

SNAG (indv diam, in) 6" 4" <6" <6" <4 <4
V5, snag count >4" 1

V6 ALL WOODY 30 / Ø /

RFCT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 50 / Ø /

V3 TREE CANOPY CLOSURE Ø / Ø /

V4 # SPECIES (list names) (4+) VO Will, Will, Unid tree w/ Sabe, Fig, BB Live Oak

V5 UNDERSTORY DENSITY @2FT 30 / 0 / @6FT 30 / ● /
@14FT 10 / 0 AVERAGE 25 / 0 /

YW MODEL: V1 DECID SHRUB COVER 30' / 0 /

V2 SHRUB HTS (ft) T1 - 1.0-1.5m Basal area
(nearest .1M) T2 - Ø large willow 20"

V3 hydrophytic SHRUB COVER 30 / Ø /
V4 tall tree 21 / Ø (willow 2.5")

DW MODEL: V1 SNAG COUNT >6", see above 1 (V1) 3/4/4) (V06)

V2 BASAL AREA (cruz-all or see HW, below) / / willow clusters

HW MODEL: V1 SNAG COUNT >10", see above 0 20/20

V2/V3 DbH oversion 6 Fig 6.5 5 (willow up to 6) 20/20 Fig 20

V4 CANOPY COVER Ø / Ø /

DATA SHEET TS_30_L HEP P. 12

DATE 12/8/21 TIME 1018am NAMES [illegible]

220 - 222 #37 send

PHOTO# ______ WYPT #38 N end PLOT#/LOCATION #12

TRANSECT TOTAL LENGTH (FT) 80 / 75 / ______

RSG MODEL: V1 (SHRUB<3M) (FT) 30 / 20 / ______ 220 150 210

V2 (indiv tree hts, ft) 45 / 25 / 25 / 40 / 25 ______ 222

V3 (TREE>3M) (FT) 20 / 30 / ______

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 / ______

SNAG (indv diam, in) (<4) 4-5" (<4) 6" ______ ______ ______

V5, snag count >4" 2

V6 ALL WOODY 60 / 65 / ______

RFCT MODEL: V1(tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 60 / 70 / ______

V3 TREE CANOPY CLOSURE 20 / 65 / ______

V4 # SPECIES (list names) Will, BW, V.O., Bi?, 2nd will ______

V5 UNDERSTORY DENSITY @2FT 50 / 30 / @6FT 50 / 40 /

@14FT 20 / 60 / AVERAGE 40 / 40 / ______

YW MODEL: V1 DECID SHRUB COVER 60 / 30 / ______

V2 SHRUB HTS (ft) T1 - 2+ m throughout ______ ______ ______

(nearest .1M) T2 - 2.1 m - all shrubs ______ ______

V3 hydrophytic SHRUB COVER 60 / 30 / ______

V4 [illegible] tree Ø / 40

DW MODEL: V1 SNAG COUNT >6", see above 1

V2 BASAL AREA (cruz-all or see HW, below) ______ / ______ / ______

HW MODEL: V1 SNAG COUNT>10", see above Ø

V2/V3 DbH overstory 14/12 18/12 [illegible] VO 25 ______ ______ ______

______ ______ ______ ______ ______ ______

V4 CANOPY COVER 15 / 40 / ______

Basal Cover

willow [illegible] 35"

BW 14/12/2/10

5/3/3/7/3

[illegible] 30"

VO 25"

SM will 25" stems

DATA SHEET TS_3 0 L HEP P. 17

DATE 12/7/21 TIME 3:30 NAMES Stephen, Jess, Mike

PHOTO# ______ WYPT ______ PLOT#/LOCATION #17

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ______

RSG MODEL: V1 (SHRUB<3M) (FT) 35 / 85 / ______

V2 (indiv tree hts, ft) 30 / 35 / 20 / 24 / 41 / 6-7 willows 20+ a few 21

V3 (TREE>3M) (FT) 70 / 30 / ______

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 / ______

SNAG (indv diam, in) 4" ______ ______ ______ ______ ______
V5. snag count >4" 1

V6 ALL WOODY 50 / 85' / ______

RFCT MODEL: V1(tree hts. see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 85 / 85' / ______

V3 TREE CANOPY CLOSURE 5% / 35% / ______

V4 # SPECIES (list names) BW, willow ______ ______

V5 UNDERSTORY DENSITY @2FT 77 / 85 / ______ @6FT 30 / 63 / ______
@14FT 10 / 25 / ______ AVERAGE 39 / 65 / ______

YW MODEL: V1 DECID SHRUB COVER 50 / 85 / ______

V2 SHRUB HTS (ft) 1.5M 2M ______ Note: interpret as 30ft
(nearest .1M) 1.0 30' 24M ______

V3 hydrophytic SHRUB COVER 50 / 85 / ______
V4 2 / 0
DW MODEL: V1 SNAG COUNT >6", see above 0

V2 BASAL AREA (cruz-all or see HW, below) ______ / ______ / ______

HW MODEL: V1 SNAG COUNT >10", see above 0
V2/V3 DbH overstory (3) 8-9" willow 20" ______ 12" BW
24" BW ______ ______ ______ ______ ______

V4 CANOPY COVER 0 / 25% / ______

Basal area 20" willow
20" willow
20" willow
24" BW
12" BW

DATA SHEET T S 30_L HEP P. 16

DATE 2/7/21 TIME 2:22 NAMES Stevens, Jess, M

PHOTO# WYPT# PLOT#/LOCATION #16

TRANSECT TOTAL LENGTH (FT) 150' / 120' / 21'

RSG MODEL: V1 (SHRUB<3M) (FT) 10 / 60 / 21

V2 (indiv tree hts, ft) 12 12 35 22 42 25

V3 (TREE>3M) (FT) 130 / 30 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 10" 4"

V5, snag count >4" 2

V6 ALL WOODY 135 / 90' /

RECT MODEL: V1(tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 135 /

V3 TREE CANOPY CLOSURE 80 /

V4 # SPECIES (list names)

V5 UNDERSTORY DENSITY @2FT 70 / 85 / @6FT 70 / 30 /
@14FT 80 / 10 / AVERAGE 77 / 40 /

YW MODEL: V1 DECID SHRUB COVER 135' /

V2 SHRUB HTS (ft)
(nearest .1M)

V3 hydrophytic SHRUB COVER 135 / 90' /

DW MODEL: V1 SNAG COUNT >6", see above 1

V2 BASAL AREA (cruz-all or see HW, below) / /

HW MODEL: V1 SNAG COUNT >10", see above 1
V2/V3 DbH overstory 16"

V4 CANOPY COVER 80 / 30' /

DATA SHEET TS_30_L HEP P. #15

DATE 2/7/21 TIME 12 42
2/11-213

PHOTO#____ WYPT ____ NAMES Steve, Jess, Mir

PLOT#/LOCATION #15 just before Bend

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ____

RSG MODEL: V1 (SHRUB<3M) (FT) 40 / 30 / ____

V2 (indiv tree hts, ft) 25 25 30 22 22 12 5 4

V3 (TREE>3M) (FT) Ø / 20 / ____

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) / (5) / ____

SNAG (indv diam, in) 10" 6" 8" 6" ____ ____

V5. snag count >4" 2

V6 ALL WOODY 50 / 50 / ____

RECT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 90 / 60 / ____

V3 TREE CANOPY CLOSURE Ø / Ø / ____

V4 # SPECIES (list names) ____ BB ____ cork oak, walnut

V5 UNDERSTORY DENSITY @2FT 50 / 70 / @6FT Ø / 30 / ____
@14FT Ø / 5 / ____ AVERAGE ____ / 30 / ____

YW MODEL: V1 DECID SHRUB COVER 50 / 50 / ____

V2 SHRUB HTS (ft) ____ guess, 5 m ____ ____ ____
(nearest .1M) ____ 22 ____ 30% ____

V3 hydrophytic SHRUB COVER 40 / 50 / ____

DW MODEL: V1 SNAG COUNT>6", see above 2

V2 BASAL AREA (cruz-all or see HW, below) ____ / ____ / ____

HW MODEL: V1 SNAG COUNT >10", see above 1

V2/V3 DbH overstory 16 8" 3" 7" 23" ____

13 1/2" walnut ____ ____ ____ ____

V4 CANOPY COVER Ø / 10 / ____

BW - 15"
Will - 10"
Will - 21"
6"
Will - 20"
- 18"
willows 30"

DATA SHEET TS_30_LHEP P. 14

DATE 3/7/21 @ 208-210 TIME 1155am J33 Send NAMES Shane Seb, Jess, Mir.

PHOTO#____ WYPT#34 Nend PLOT#/LOCATION #14

TRANSECTTOTALLENGTH (FT) 100 / 100 /

RSG MODEL: V1 (SHRUB<3M) (FT) 32 / 40 /

V 3 (indiv tree hts, ft) 25 (V) 20 20 25 BW 20

V 2 (TREE>3M)(FT) 45 / 30 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 4" 6" 8" (~4 x 3', some lower or bigger

V5, snag count >4" 3+

V6 ALL WOODY 77 / 74' /

RFCT MODEL: V1(tree hts. see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 100 /

V3 TREE CANOPY CLOSURE 40% 30% /

V4 # SPECIES (list names) 3 Fuzzy, W, Pollard, Bal, UNID, Fuzzy brown bush

V5 UNDERSTORY DENSITY @2FT 80 / 60 / @6FT 50 / 35 /
@14FT 40 / 20 / AVERAGE 55 / 30 /

YW MODEL: V1 DECID SHRUB COVER 77 / 74 / Baccharis

V2 SHRUB HTS (ft) 1.3m Bac ½ + ½ 2m + willow BW 4 x 4
(nearest .1M) ~~Ta 0.7 x 60% + 40% 2 m~~ BW total 20'

V3 hydrophytic SHRUB COVER 77 / 74 / willow total 1.3
(V4 willow - 20 / 5 willow ~ 20 stems

DW MODEL: V1 SNAG COUNT >6", see above 2+

V2 BASAL AREA (cruz all or see HW. below) see all method willow 15, SW willow ~15

HW MODEL: V1 SNAG COUNT >10", see above Ø

V2/V3 DbH overstory (7 1/4" willow) 12" willow BW, 4-5 stems 8") Fuzzy 6"

____ ____ ____ ____ ____ ____

V4 CANOPY COVER 30% / 20% / (6m+)

DATA SHEET TS30_L HEP P. #13

DATE 12/7/21 TIME 10:47am NAMES Stewart, Jess, M...

PHOTO# 4205-4208 WYPT# 332 end PLOT#/LOCATION #13

TRANSECT TOTAL LENGTH (FT) 100 / 100 /

RSG MODEL: V1 (SHRUB<3M) (FT) 80 / 80 /

V2 (indiv tree hts, ft) 38 25 18 20 30

V3 (TREE>3M) (FT) 5 / 5 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 4 4 5 4
V5, snag count >4" 4

V6 ALL WOODY 85 / 85 /

RFCT MODEL: VI (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 / 100 / /

V3 TREE CANOPY CLOSURE 5 / Ø /

V4 # SPECIES (list names) BW, Hackberry, Willow, Red ...

V5 UNDERSTORY DENSITY @2FT 90 / 90 / @6FT 30 / 50 /
@14FT 0 / 0 / AVERAGE 35 / 35 /

YW MODEL: V1 DECID SHRUB COVER 80 / 80 /

V2 SHRUB HTS (ft) (nearest .1M) T1 - 1m BB, .3m BB, 2m+ Willow
T2 - 2m+

V3 hydrophytic SHRUB COVER 80 / 80 /
RV4 - tall tree Ø/Ø

DW MODEL: V1 SNAG COUNT >6", see above Ø

V2 BASAL AREA (cruz-all or see HW, below) / /

HW MODEL: V1 SNAG COUNT>10", see above Ø
V2/V3 DbH overstory 10 12 6 10 15 BW 30" willow
18"

V4 CANOPY COVER Ø / Ø /

BW 6x5'
Hb 20x15'
willow 20x7'
BW 6x4
BW -24" total
BW 24" total
willow 45'+

DATA SHEET T 1S_30_L HEP P. 2

DATE 8/7/21 TIME 9:13AM NAMES Stewsh, Jesse, Mi
(#202)

PHOTO# ______ WYPT ______ PLOT#/LOCATION #12, Justaurus, R3

TRANSECT TOTAL LENGTH (FT) 100, 100,

RSG MODEL: V1 (SHRUB<3M) (FT) 55 / 40 /

V2 (indiv tree hts, ft) 33 / 20 / 4x2 / 25

V3 (TREE>3M) (FT) 30 / 3 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 28" 22" 4" 4"

V5, snag count >4" 4

V6 ALL WOODY 100 / 75 /

RECT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 / 100 /

V3 TREE CANOPY CLOSURE 20 / 30 /

V4 # SPECIES (list names) BW, BB, Wil, Oak

V5 UNDERSTORY DENSITY @2FT 95 / 80 / @6FT 60 / 80 /
@14FT 20 / 50 / AVERAGE 60 / 70 /

YW MODEL: V1 DECID SHRUB COVER 95 / 75 /

V2 SHRUB HTS (ft) T1 - predominantly 2+ m
(nearest 1M) T2 - BB (1.5m) + ~~...~~ 2+ Bw

V3 hydrophytic SHRUB COVER 95 / 75 /

DW MODEL: V1 SNAG COUNT >6", see above 3

V2 BASAL AREA (cruz-all or see HW, below) / /

HW MODEL: V1 SNAG COUNT >10", see above 2

V2/V3 DbH overstory 14 13 32 4" 4 8

V4 CANOPY COVER 20 / 20 /

Box elder

Willow
9 x 20
1 x 20
30 BW
15" BW

DATA SHEET TS_30_L HEP P. 11

DATE 12/3/21 TIME 4:18 pm NAMES Sch, McL, Sc...

PHOTO# 199-201 WYPT ______ PLOT#/LOCATION #11 Past pond... just before ...

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ______

RSG MODEL: V1 (SHRUB<3M) (FT) 40 / 100 / ~~...~~ 201 60 199 120 200

V2 (indiv tree hts. ft) 35 25 30 20

V3 (TREE>3M) (FT) 40 / Ø / ______

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 / ______

SNAG (indv diam, in) 10+ 10"+ 10+

V5. snag count >4" ______

V6 ALL WOODY 100 / 100 / ______

RECT MODEL: V1(tree hts. see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 / 100 / ______

V3 TREE CANOPY CLOSURE 40 / Ø / ______

V4 #SPECIES (list names) Box, W, 1, BE

V5 UNDERSTORY DENSITY @2FT 70 / 100 / ______ @6FT 70 / 60 / ______

@14FT 40 / 20 / ______ AVERAGE 60 / 60 / ______

YW MODEL: V1 DECID SHRUB COVER 90 / 100 / ______

V2 SHRUB HTS (ft) (nearest .1M) T1 - 1.5m+ T2 - 1.5 - 2.5m

V3 hydrophytic SHRUB COVER 40 / 100 / ______

(V1 full tree 20 / Ø

DW MODEL: V1 SNAG COUNT >6", see above 3

V2 BASAL AREA (measure all or see HW. below) (No measure ______ / ______ / ______

HW MODEL: V1 SNAG COUNT >10", see above 3

V2/V3 DbH overstory 6 6 ...

V4 CANOPY COVER 30 / Ø / ______

Basal areas
8 wil
10 BW
20 Box(...
5 ...
...
2.5 ...
3.5 ...
...
<20 20

DATA SHEET TS_30_L HEP P. 10

DATE 12/8/21 TIME 329pm NAMES Steve, Matt-Sch, Sav

PHOTO# 196 197/198 WYPT Mark#30 end#29 PLOT#/LOCATION #10 under power line

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ____ 175 30 197 220 198

RSG MODEL: V1 (SHRUB<3M) (FT) 30 / 60 / ____

V2 (indiv tree hts, ft) ~15-20 (~20-25) ____ ____ ____ ____

V3 (TREE>3M) (FT) 70 / 40 / ____

V4 LAYER CATEGORY (SELECT 1,2,3,4 ,5) 5 / 5 shrub / ____

SNAG (indv diam, in) 6" Broken trunk ____ ____ ____ ____ ____
V5, snag count >4" 1

V6 ALL WOODY 100 / 100 / ____

RFCT MODEL: V 1(tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 / 100 / ____

V3 TREE CANOPY CLOSURE 90+ / 30% / ____

V4 # SPECIES (list names) BS, BW, UNID willow, Red-twig, UNID mountain top

V5 UNDERSTORY DENSITY @2FT 100 / 100 / ____ @6 FT 80 / 80 / ____
@14FT 70 / 50 / ____ AVERAGE 80 / 80 / ____

YW MODEL: V1 DECID SHRUB COVER 100 / 100 / ____

V2 SHRUB HTS (ft) T1 - 2m ____ ____ ____ ____
(nearest .1M) T2 - 20% 1.2-1.5 BB; see below, then 2m ...

V3 hydrophytic SHRUB COVER 100 / 100 / ____
(V4 tall tree - (0/10))

DW MODEL: V1 SNAG COUNT >6", see above 1

V2 BASAL AREA (cruz-all or see HW, below) ____ / ____ / ____

HW MODEL: V1 SNAG COUNT >10", see above Ø
V2/V3 DbH overstory 15" leaf/tree 10" willow ____ ____ ____

____ ____ ____ ____ ____ ____

V4 CANOPY COVER 15 / 12.5 / ____

Missing Data Photos 196, 197 show very dense willows

estimate 2-3" x 50 x 300 ... 30000 ... 15" ... 9' ...

DATA SHEET T S_30_L HEP P. 9

DATE 2/3/2 ° TIME 2:30pm NAMES Steve S., Steve M., Suzanne h

PHOTO# 193 194,195 WYPT 428 PLOT#/LOCATION #9

TRANSECT TOTAL LENGTH(FT) 60 / 50 / ____

RSG MODEL: V1 (SHRUB<3M) (FT) 60 / Ø / ____

V2 (indiv tree hts. ft) 25 25' ____ ____ ____ ____

V3 (TREE>3M) (FT) Ø / 40 / ____

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) (5) / ____ / ____

(Note: Not Recorded - noted observed)

SNAG (indv diam,i:1) ____ ____ ____ ____ ____ ____

V5, snag count>4" ____

V6 ALL WOODY 60 / 50 / ____

RFCT MODEL: V1 (tree hts. see above) 25

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 60 / 50 / ____

V3 TREE CANOPY CLOSURE Ø / 25 / ____

V4 #SPECIES (list names) BW, RW, Cottonwood, Red oak seedling

% V5 UNDERSTORY DENSITY @2FT / 100 / @6FT 5 / 80 / ____
@14FT 0 / 80 / ____ AVERAGE / 80 / ____

YW MODEL: V1 DECID SHRUB COVER 60 / 50 / ____

V2 SHRUB HTS (ft) mostly 1.8M B.B. Nothing else ____ ____
(nearest .1M) 3 Willows 2+ 0 ____ ____ ____

V3 hydrophytic SHRUB COVER 60 / 50 / ____

(Vegetation Ø / Ø)

DW MODEL: V1 SNAG COUNT >6", see above ____

V2 BASAL AREA (cruz-all or see HW, below) ____ / ____ / ____

HW MODEL: V1 SNAG COUNT >10", see above ____

V2/V3 DbH overstory ~8" ( ) (22, 21), 8 smaller BW ____

____ ____ ____ ____ ____ ____

V4 CANOPY COVER 0' / 25' / ____

DATA SHEET TS_30_L HEP P. 8

DATE 2/3/21 TIME 1:20pm NAMES Steve Sch

PHOTO# #190-192 WYPT #275 #221 PLOT#/LOCATION #8 South

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ____

RSG MODEL: VI (SHRUB<3M) (FT) 40 / 25 / ____

V2 (indiv tree hts, ft) 20 + 21 30 20 25 20 25

V3 (TREE>3M) (FT) 60 / 75 / ____

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / ____ / ____

SNAG (indv diam, in) 4+ 4+ ____ ____ ____ ____

V5, snag count >4" ____

V6 ALL WOODY 85 / 100 / ____

RECT MODEL: VI (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 85 / ____ / ____

V3 TREE CANOPY CLOSURE 50% / 3% / ____

V4 # SPECIES (list names) ____

V5 UNDERSTORY DENSITY @2FT 85 /100 / @6FT 60/80 / ____

@14FT 55/40 / ____ AVERAGE ____ / ____

YW MODEL: VI DECID SHRUB COVER 85 / 100 / ____

V2 SHRUB HTS (ft) 1.1 1.3 1.2 Rest >2m ____ ____

(nearest .1M) T2+.6=1.8 ~~shrub~~ Rest >2m ____ ____

V3 hydrophytic SHRUB COVER 85 / 100 / ____

V4 tall tree 0 / 0

DW MODEL: VI SNAG COUNT >6", see above ____

V2 BASAL AREA (cruz-all or see HW, below) Not possible ____ / ____ / ____

HW MODEL: VI SNAG COUNT >10", see above

V2/V3 DbH overstory ____ ____ ____

____ ____ ____ ____ ____ ____

V4 CANOPY COVER 50 / 25 / ____

DATA SHEET 1S_30_L HEP P. 7

DATE 12/3/21 #187 TIME 11:55 Next # 27 NAMES Steve M, Sch, Sav.

PHOTO# # 188-189 WYPT end #26 PLOT#/LOCATION 47, 187

210 200

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ___

RSG MODEL: V1 (SHRUB<3M) (FT) 30 / [missing data]

V2 (indiv tree hts. ft) 10 10 10 40 30 18'

V3 (TREE>3M)(FT) 70 / 60 / ___

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 / ___

SNAG (indv diam, in) 10 10 10 8+ 8+ 6"
V5, snag count >4" 6+

V6 ALL WOODY 90 / 90 / ___

RECT MODEL: V1(tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 90 / 90 / ___

V3 TREE CANOPY CLOSURE 60 / ___

V4 # SPECIES (list names) BW, BR, ko 4

V5 UNDERSTORY DENSITY @2FT 100 / 80 / @6FT 70 / 50 /
@14FT 60 / ___ AVERAGE 80 / 65 / 170/3=55

YW MODEL: V1 DECIDSHRUBCOVER 90 / 90 / 80

V2SHRUBHTS (ft) 30% BB 1.2-1.4 2 in
(nearest .1M)

V3 hydrophytic SHRUB COVER 90 / 90 / ___
ø / 20%

DW MODEL: V1 SNAG COUNT >6", see above 6+

V2 BASAL AREA (cruzall or see HW, below) NO / est / ___

HW MODEL; V1 SNAG COUNT >10", see above 3
V2/V3 DbH overstory 10" 15"

V4CANOPYCOVER 60 / 30 / ___

DATA SHEET TS_30_LHEP P. 6

DATE 2/3/21 TIME 1102am NAMES Steve M, Steve Sh, Sarah

PHOTO# 184-186 WYPT Mead #26 PLOT#/LOCATION Plot 6 (between power lines)

TRANSECT TOTAL LENGTH (FT) 100 / 100 /

RSG MODEL: V1 (SHRUB<3M) (FT) 70 / 95 / 184

V2 (indiv tree hts, ft) 53' (willow) ~5 willows ~25-30' tall by channel

V3 (TREE>3M) (FT) 50 / 55 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) ~6-8"
V5 snag count>4" 1

V6 ALL WOODY 70 / 90 /

RFCT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 85 / 90 /

V3 TREE CANOPY CLOSURE 5% / 50% /

V4 # SPECIES (list names) Willow, BB, eld, silverleaf

V5 UNDERSTORY DENSITY @2FT 100/100/ @6FT 60/75/
@14FT 20/55/ AVERAGE

YW MODEL: V1 DECID SHRUB COVER 70 / 90 /

V2 SHRUB HTS (ft) T1 - 1.1, 1.8, (50% BB, 50% - 2m tall)
(nearest .1M) T2 1.5 ( ), 50% 2 tall willow

V3 hydrophytic SHRUB COVER 70 / 90 /
(V4 willow - 30% - T2 only)

DW MODEL: V1 SNAG COUNT >6", see above 1

V2 BASAL AREA (cruz-all or see HW, below) / /

HW MODEL: V1 SNAG COUNT >10", see above Ø
V2/V3 DbH overstory willow 2.0" dense willows 6"/sq m T1

willow ~6" (T2)

V4 CANOPY COVER Ø / 30' /
6m+

DATA SHEET TS_30_L HEP P. 5

DATE 12/3 TIME 930am NAMES Shrea, Steve S., S...

PHOTO# 182 183 WYPT ... PLOT#/LOCATION 5

TRANSECT TOTAL LENGTH (FT) 100 / 100 /

RSG MODEL: V1 (SHRUB<3M)(FT) 10 / 20 /

V2 (indiv tree hts, ft) ... = 30' ... = 25'

V3 (TREE>3M) (FT) 80 / 80 /

V4 LAYER CATEGORY (SELECT 1 2 3 4 5) 5 / 5 /

SNAG (indv diam, in) (... can't see any)

V5, snag count >4"

V6 ALL WOODY 90 / 100 /

RFCT MODEL: V1 (tree hts, see above) ~30-35'

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 90 / 100 /

V3 TREE CANOPY CLOSURE 80 / 80 /

V4 # SPECIES (list names) ...

V5 UNDERSTORY DENSITY @2FT 90 / ... / @6FT 90 / 80 /
@4FT 85 / 90 / AVERAGE ... / ... /

YW MODEL: V1 DECID SHRUB COVER 90 / 100 /

V2 SHRUB HTS (ft) T1 - 20% 1.4 80% 2+ ...
(nearest .1M) T2 - 20% 1.3 80% 2+ ...

V3 hydrophytic SHRUB COVER 90 / 100 / ... and photos 181 and 182

V4 (Note - forgot to record ... est. 30% ...

DW MODEL: V1 SNAG COUNT>6", see above — ... 6+"/ ... trees

V2 BASAL AREA (cruz all or see HW, below) — / — /

HW MODEL: V1 SNAG COUNT >10", see above —
V2 /V3 DbH overstory ... (4, 8, 6 ...

some with larger — look in Corps notes

V4 CANOPY COVER 60 / 70 / /
est est

DATA SHEET TS_30_L HEP P. 4

DATE 12/2 TIME 3:30 NAMES Steve, Jess, Sam

PHOTO# 123-180 WYPT 24-N 23-S PLOT#/LOCATION #4

TRANSECT TOTAL LENGTH (FT) 100 / 100 /

RSG MODEL: V1 (SHRUB<3M) (FT) 50 / 90 /

V2 (indiv tree hts, ft) 55 35

V3 (TREE>3M) (FT) 20 / 70 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 5" 6" 6" 5+"

V5, snag count >4" 4

V6 ALL WOODY 70 / 90 /

RFCT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 100 / 90 /

V3 TREE CANOPY CLOSURE 20 / 70 /

V4 # SPECIES (list names) BB, Willow, Butternut, ..., Silver

V5 UNDERSTORY DENSITY @2FT 70 90 @6FT 30/80/

@14FT 20 60 AVERAGE

YW MODEL: V1 DECID SHRUB COVER 50 / 90 /

V2 SHRUB HTS (ft) (nearest .1M) 1.6 m 2+m

V3 hydrophytic SHRUB COVER 50, 90 /

DW MODEL: V1 SNAG COUNT>6", see above 0

V2 BASAL AREA (cruz-all or see HW, below) /

HW MODEL: V1 SNAG COUNT >10", see above 0

V2/V3 DBH overstory 30" 7" 4" 4" 6" 6"

8" 7" 6" 10"

V4 CANOPY COVER 20 / 50 /

non-native dominance? NO

DATA SHEET TS_30_L HEP P._3

DATE 12/2/21 TIME 1:10pm NAMES Jessica/Samantha/Sten

PHOTO# 175-177 WYPT 21-Seal 22-Nead PLOT#/LOCATION #3

TRANSECT TOTAL LENGTH (FT) 120 / 100 /

RSG MODEL: V1 (SHRUB<3M) (FT) / /

V2 (indiv tree hts, ft) 30' 47' 25 41'

V3 (TREE>3M) (FT) 80' / 80' /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 2 /

SNAG(indvdiam, in) 6"

V5, snag count >4" 1

V6 ALL WOODY 120' / 90' /

RFCT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 120' / / /

V3 TREE CANOPY CLOSURE 80' / 50' /

V4 # SPECIES (list names) willow, CB, ash, walnut

V5 UNDERSTORY DENSITY @2FT 80 / 100 @6FT 80 / 100 /
@14FT 40 80 AVERAGE 50 / 90 /

YW MODEL: V1 DECID SHRUB COVER 60' / 100' /

V2 SHRUB HTS (ft) T1 - all 2+ M
(nearest .1M) T2 - all 2+ M

V3 hydrophytic SHRUB COVER 70' / 100' /
(V4 ... 30') 60% / 0 ← But ... walnut 10%

DW MODEL: V1 SNAG COUNT>6", see above 1

V2 BASAL AREA (cruz-all or see HW, below) 2x10 / ... 6

HW MODEL: V1 SNAG COUNT >10", see above 0

V2/V3 DbH overstory 26 16 16 16 14 4

4 11 15 16

V4 CANOPY COVER 80' / 20' /

not much tree at transect

... dominance - ... but not >50%

DATASHEET TS_30_L HEP

P. 3

DATE 2/2/21 TIME 11:52am NAMES Steve, Jess [illegible]

PHOTO# 72-174 WYPT #5 #20 PLOT#/LOCATION #2 goes out towards big [illegible] clump

TRANSECT TOTAL LENGTH (FT) 100 / 100 / ___ ← estimated 100 from map

RSG MODEL: V1 (SHRUB<3M)(FT) 77 / 82 / 174 30 172 173

V2 (indiv tree hts, ft) T1 - many willows 16-20' tall ; 55'

V3 (TREE>3M) (FT) 77 / 82 /

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / 5 /

SNAG (indv diam, in) 6" 10" 10"

V5, snag count >4" 3

V6 ALL WOODY 77 / 82 / includes None [illegible]

RFCT MODEL: V1(tree hts. see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 77 / 82 /

V3 TREE CANOPY CLOSURE 20 / (Not [illegible])

V4 # SPECIES (list names) BB, willow, [illegible] willow

V5 UNDERSTORY DENSITY @2FT 77 / 82 / @6FT 77 / 82 / (willow [illegible] area)

@14FT 30 / 80 AVERAGE [illegible] / 72

YW MODEL: V1 DECID SHRUB COVER 77 / 82 /

V2 SHRUB HTS (ft) numerous 7ft willow

(nearest .1M)

V3 hydrophytic SHRUB COVER 77 / 82 /

(V4 - tall trees) - 0

DW MODEL: V1 SNAG COUNT >6", see above 3

V2 BASAL AREA (cruz-all or see HW, below) (not [illegible]) 3-4 / sq m

HW MODEL: V1 SNAG COUNT >10", see above 2

V2/V3 DbH overstory T1 - 4 [illegible] 2.50 - 18, 16

V4 CANOPY COVER 20% (76m) / (Cannot see heterogeneous) 20% if inside [illegible] grass / nonnative dominant? (NO) overall plot.

DATA SHEET TS_30_L HEP P. 1

DATE 12/2/21 TIME 9:30am NAMES Schwenb... , ..., Savannah

PHOTO# 100- 100-0170 WYPT #3 - Neal ±4-5 ... PLOT#/LOCATION 1st plot ...

TRANSECT TOTAL LENGTH (FT) 65 / 100 / ______

RSG MODEL: V1 (SHRUB <3M) (FT) 18 / 79 / ______

V3 (indiv tree hts, ft) 14' 50' 20' 22' willow ______ other ... 20+

V2 (TREE>3M) (FT) 12' / 70' / ______

V4 LAYER CATEGORY (SELECT 1,2,3,4,5) 5 / ______ / ______ / ______

SNAG (indv diam, in) 10" est ...

V5, snag count >4" 1

V6 ALL WOODY 18 / 79' / ______

RECT MODEL: V1 (tree hts, see above)

V2 RIPARIAN STAND WIDTH (all woody + small gaps) 20 / ... / ______ plot ... 204 ... 171

V3 TREE CANOPY CLOSURE 0 / 20 / ______

V4 # SPECIES (list names) ... ash, willow, oak 4 ... 4

V5 UNDERSTORY DENSITY @2FT 30/80 / ______ @6FT 15 / 60 / ______
@14FT 0 / 20 / ______ AVERAGE 15/55 / ______

YW MODEL: V1 DECID SHRUB COVER 18 / 79 / ______

V2 SHRUB HTS (ft) 2+ 0.9 1.2 (numerous willows 2+m)
(nearest .1M) average 2+

V3 hydrophytic SHRUB COVER 18 / 79 /
(V4 tall tree - photo ... [No tree ...] = ... willow est ...

DW MODEL: V1 SNAG COUNT >6", see above 1

V2 BASAL AREA (calc all or see HW, below) see ... calc / ______ / ______

HW MODEL: V1 SNAG COUNT >10", see above 1
V2/V3 DbH overstory (9 10 10 6) - willows ______ ______

V4 CANOPY COVER 10? / 25 / ______
... Tallest willows est 22' tall

APPENDIX D. Plates

Plate 1: TS_30_L impact area; 3-41 are plot boundary waypoints (see Appendix C, datasheets).

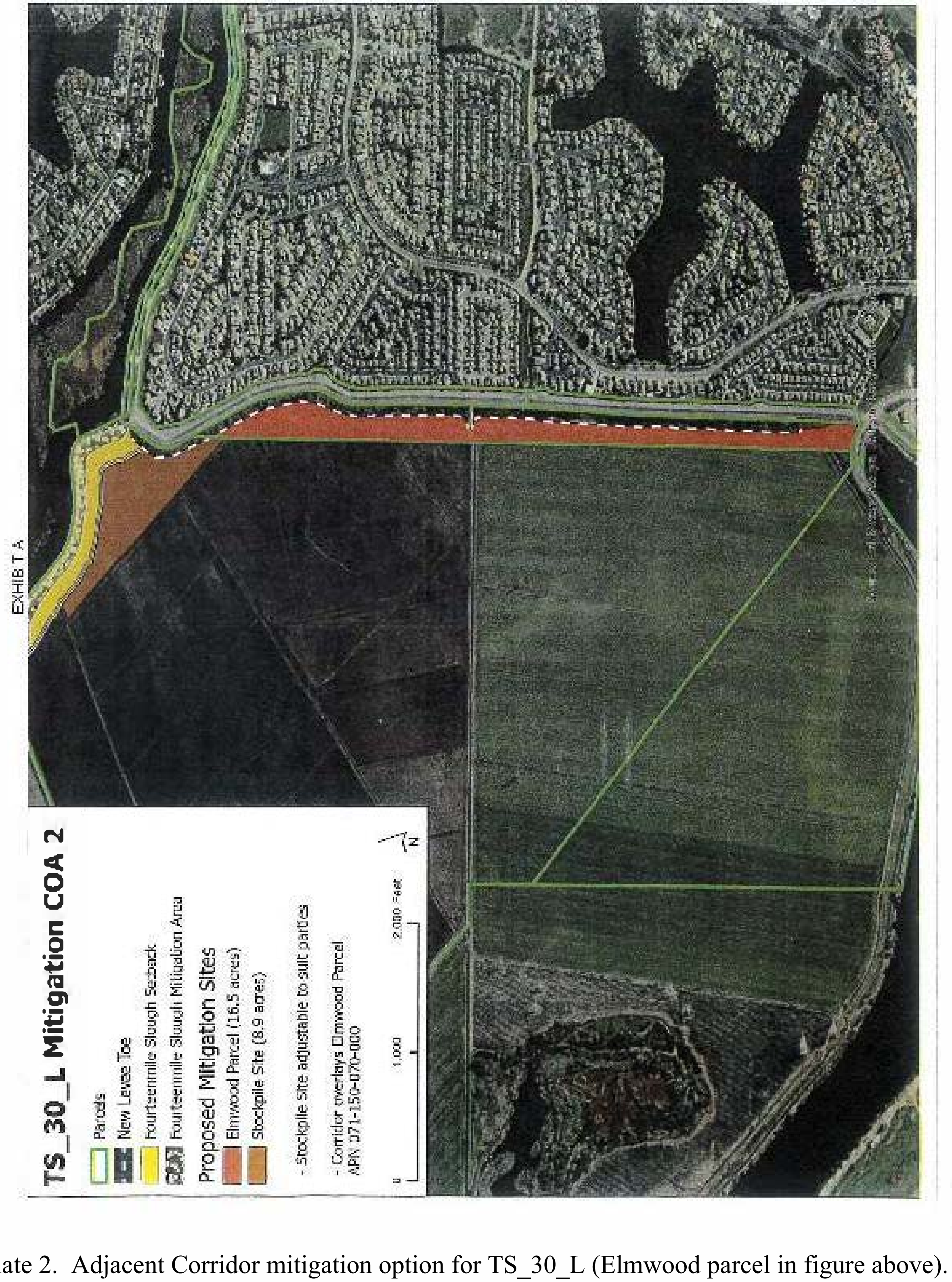


Plate 2. Adjacent Corridor mitigation option for TS_30_L (Elmwood parcel in figure above).

Plate 3: Location of non-adjacent mitigation options for TS_30_L.

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer To:
08ESMF00-2015-F-0206

JUN 13 2016

Ms. Alicia Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Formal consultation on the Lower San Joaquin River Feasibility Study, San Joaquin County, California

Dear: Ms. Kirchner:

This is in response to your November 6, 2015, letter requesting formal consultation with the U.S. Fish and Wildlife Service (Service) on the Lower San Joaquin River Feasibility Study Recommended Plan (LSJRFS), San Joaquin County, California. The LSJRFS is a Federal project with the U.S. Army Corps of Engineers (Corps) as the Federal lead agency and the Central Valley Flood Protection Board and the San Joaquin Area Flood Control Agency (SJAFCA) as the non-Federal local sponsors partnering with the Corps. The LSJRFS consists of improvements to about 24 miles of levees in the Central and North Stockton areas to address seepage, slope stability, overtopping, and erosion concerns. At issue are effects of the LSJRFS on the federally-listed as threatened valley elderberry longhorn beetle (*Desmocerus californicus*) (beetle), giant garter snake (*Thamnophis gigas*) (snake), delta smelt (*Hypomesus transpacificus*), and delta smelt critical habitat. Your request was received on November 10, 2015. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act). The findings in this consultation are based on the November 2015 Biological Assessment (BA) included with your letter, the February 2015 Draft Integrated Interim Feasibility Report/Environmental Impact Statement/Environmental Impact Report, site visits to the project area, discussions with Corps staff, consultation with species experts, and other information in our files.

CONSULTATION HISTORY

February 27, 2015: Corps transmits letter and BA requesting formal consultation.

June 8, 2015: Service transmits letter requesting additional information.

November 6, 2015: Corps transmits revised BA.

December 9, 2015: Following review of the BA, Service requests Tables E1, E2, and E3, discussed in the BA, and verification that the Corps is consulting on effects of the project construction, ETL (i.e., Engineering Technical Letter ETL 1110-2-583, dated April 30, 2014, entitled "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures") compliance, and operation and maintenance.

December 10, 2015: Corps transmits email with attachment "Table E: Pre-project vegetation and vegetation lost from project implementation." Corps (Tanis Toland) confirms by follow up telephone call that it is consulting on ETL compliance and operation and maintenance, to the extent known, as well as project construction. Service transmits email requesting information on how snake habitat was determined. Corps responds by email with explanation of determination of snake habitat.

December 16, 2015: Service responds to December 10, 2015, Corps emails regarding scope of consultation and determination of snake habitat, questioning that determination and requesting a site visit.

December 18, 2015: Corps transmits email providing additional elements of operations and maintenance expected with the future condition.

January 7, 2016: Service staff (Steve Schoenberg) attends site visit to project area with the Corps (Tanis Toland, Ryan Larson) and SJAFCA (Eric Ambriz, Matthew Ward). The descriptions of future maintenance in the project description of this biological opinion are based in part on discussions at this site visit.

January 21, 2016: Service requests, and Corps transmits, an attached shapefile of the project footprint with areas, work types, and other information by email.

January 22, 2016: Corps staff (Tanis Toland) informs Service via telephone call of project changes, namely, the Dad's Point floodwall may be a berm, and the setback mitigation area will be modified (i.e., extended south, still within reach FM_30_L).

February 9, 2016: Corps transmits email to Service stating that erosion protection for Duck Creek element has been deleted.

February 23, 2016: Service requests a description of ongoing and future channel maintenance between levees by email to Corps.

February 26, 2016: Corps transmits email attachment to Service of revised BA Table C-1 with all cost reach lengths (used in Appendix A of this biological opinion). Corps transmits email and attachment describing channel maintenance between levees.

March 7, 2016: Corps transmits email clarifying that it previously considered, but no longer intends, to seek a "SWIF" (System Wide Improvement Framework) for the LSJRFS.

March 9, 2016: Service transmits its analysis of snake habitat impacts and a request for the Corps to revise its snake habitat estimates via email.

March 10, 2016: Corps transmits email and attachment with updated impacts to snake habitat.

March 18, 2016: Service transmits emails to the Corps: (a) a request for an accounting of beetle habitat (elderberry shrubs) within project footprint and (b) a draft biological opinion to the Corps with a request for comment or otherwise concurrence with the project description, including revised conservation measures. Corps responds with emails describing locations of shrubs within the project footprint (includes easements) and 100 feet of that footprint.

March 30, 2016: Corps transmits consolidated team comments on draft biological opinion.

April 7, 2016: Service transmits email requesting updated vegetation loss estimates reflecting the Corps' March 30, 2016, comments (i.e., comment T4), and verifying the footprint of elderberry shrub effects.

April 12, 2016: Service transmits emails with (a) its analysis of footprint elderberry shrub losses, and (b) inconsistencies between the BA Table and subsequent Table E (see December 10, 2015, above) regarding vegetation loss estimates.

April 13, 2016: Corps transmits example response explanation of vegetation loss estimates and tabular inconsistencies. Service responds with emails (a) requesting a conference to resolve these inconsistencies, and (b) proposed edits to Table E to correct possible errors.

April 14, 2016: Corps sends email response to Service stating: (a) it has no information on Smith Canal water quality, (b) guidance language on limiting mitigation duration to when success criteria are met, (c) concurrence that channel maintenance practices are not part of this consultation, (d) request that the Service recheck snake conservation measures, specifically - whether the alternative use of fencing or continuous monitoring can be applied to reaches other than those specified in the draft biological opinion, and (e) concurrence with the Service's suggested grouting conservation measure. With respect to the snake conservation measures, Service staff (Steve Schoenberg) explained by phone call to Corps staff (Josh Garcia) that we had limited the use of fencing to those reaches where we deemed it reasonable to install fencing due to site conditions and would not agree to apply this option to other reaches for which continuous monitoring only is prescribed. The Service explained that the "no effect" language for certain reaches with limited conservation measures was intended to mean the effect after implementation of those conservation measures.

April 14, 2016: Service sends email with attachments showing revisions to Table E (see Appendix B), separating out the impacts of elderberry shrubs in the footprint only (see Table 1), and requests Corps concurrence. Corps (Josh Garcia, Anne Baker) sends emails concurring with these revisions.

April 18, 2016: Service transmits second draft biological opinion to the Corps with additional and/or revised conservation measures, mostly discussed previously. Among other changes, this includes revising (reducing) proposed beetle habitat impacts to those in the footprint only, and avoiding impacts to habitat within 100 feet of the footprint with measures, and confirming the effectiveness of such avoidance measures by post-construction monitoring.

April 22, 2016: Corps responds with review comments on the second draft biological opinion.

May 2, 2016: Service transmits third draft biological opinion to the Corps with a request for concurrence with the project description including conservation measures.

May 3, 2016: Corps responds that it concurs with the project description and conservation measure language and requests a small change in the placement of the compensation measure and language for effects on animal burrows of construction and grouting. Service and Corps staff confer by telephone and reach agreement on this language.

May 24, 2016: Service and Corps staff participate in teleconference to clarify closure gate description in the revised BA.

June 2, 2016: Corps provides updated analysis of closure gate operations including operating criteria, frequency, and duration.

June 3, 2016: Corps provides projected closure gate durations under an intermediate sea level rise scenario for 10 representative water years.

BIOLOGICAL OPINION

Description of the Action

The action covered by this consultation includes construction of the project, activities concurrent with construction to bring the project elements into compliance with Corps vegetation policies as described in the ETL, and operation and maintenance activities after construction.

Construction Activities:

The construction work consists of flood protection improvements involving 24 miles of levees in the Stockton area. The purpose of this work is to address seepage, slope stability, overtopping, and erosion concerns of levees adjacent to urban areas. Construction will occur on Mosher, Tenmile, Fivemile, Fourteenmile, and French Camp Sloughs, the San Joaquin and Lower Calaveras Rivers, Duck Creek, and Shima Tract. A variety of treatments and combination of flood control measures will be done to improve levees depending on specific location, including 20.1 miles of cutoff walls, 6.1 miles of geometric improvement (slope and crown reshaping), 3.5 miles of levee raises, 3 miles of seismic protection, 4.9 miles of erosion protection, and 0.95 mile of new levee[1]. The project also includes construction of two new in-water closure structures.

Cutoff Wall

The predominant measure proposed to improve levee performance will be installation of a vertical wall of low hydraulic conductivity material through the middle of the levee known as a slurry cutoff wall. The depth of the wall extends through and beyond the embankment and foundation and is usually tied into an impervious sub-layer. The methods used will be either the conventional open trench method for depths 70-80 feet (ft) or less, or the deep soil mixing

[1] Quantities are approximate linear distances; work width and total area of work vary with location and depend on levee height and other factors. The floodwall now to be substituted with a berm is considered new levee.

method for depths >80 ft. For either method, construction sites will be cleared, grubbed, and stripped of all vegetation, and the levee will be degraded to about half its height in order to provide sufficient working surface (~30 ft). After the slurry has hardened it will be capped, and the levee embankment reconstructed (or raised) as specified with impervious or semi-impervious soil. The levee soil surfaces will be hydroseeded after construction unless specified as crown roads or for erosion protection (see below). Equipment used for this type of feature will include heavy equipment such as haul trucks, front end loaders, bulldozers, cranes, backhoes and/or a long-trench excavator, scrapers, and various machinery for an on-site batch plant (where needed). This measure will be applied to Mosher Creek, Shima Tract, the lower Calaveras River, French Camp Slough, and portions of the San Joaquin River and Duck Creek.

In some areas which cannot be easily accessed such as around utilities and at bridges along levees, a jet grouting method will be used to install the cutoff wall. This involves rotary/rotary percussive methods to drill and fill interconnected columns with impermeable grout. Equipment consists of a drill rig and string, a high pressure/flow pump, batch plant, and associated generators, compressors, tanks, and silos.

Levee Reshaping (“geometric fix” or slope reshaping)

This measure involves grading high areas, and/or placing additional soil fill and compacting it to meet Corps design criteria for side slope (2 or 3:1) and crown width (12 or 20 ft). This requires clearing and grubbing the waterside crest edge, and stripping the landsides slope to remove 0.5-1 ft of material, and occasionally up to 2 ft of material. Material needed to correct levee geometry will be placed only on the land side, but reshaping may occur on both land and water sides. If this reshaping requires removal of rock revetment, the rock will be replaced. Relocation of land side toe drains and ditches will be done where required. The equipment needed is similar to levee raising (see below). This measure will be applied to portions of Tenmile Slough, the Calaveras and San Joaquin Rivers, and a portion of Duck Creek.

Seismic Remediation (Seismic Fix)

This measure involves a deep soil mixing technique to prevent liquefaction during a seismic event and also reduces seepage and increases landside slope stability. This technique is used to install a drilled grid of soil-cement mixture columns. There will be a series of overlapping such columns aligned longitudinally with and transverse to the levee alignment and which will extend beyond the levee prism. This measure will be applied to Fivemile, Fourteenmile, and a portion of Tenmile Sloughs.

For construction of this measure, areas will be cleared and grubbed. Except for Fourteenmile Slough, levees will be degraded to half their height, and the degrade material placed landward to form an extension of the existing levee. Deep soil mixing augers will be used to construct the columns, which will be filled with cement-bentonite slurry during the auguring. The levee crest will be topped with a 6-inch-thick aggregate road and the levee slopes reseeded.

In the portion of the project along Fourteenmile Slough where a setback is proposed as part of a conservation measure, seismic remediation measures will be constructed landward (west) of the setback from the slough, and a new levee will be constructed there. The old levee will be partially degraded. The land between the new and old levees will become a mitigation area for project impacts. The setback width will be 60-90 ft, and will occur within reach FM_30_L.

Levee Raise

This measure is prescribed where either the levee crown has slumped or to raise the existing levee height to maximize benefits. It is proposed for portions of Mosher Creek, Fourteenmile Slough, and the San Joaquin River. All of these areas also will have either a cutoff wall or seismic fix specified as well as erosion protection for Fourteenmile Slough only. Borrow material will be added to the land side after cutoff walls and levee reshaping improvements are completed. Any crown roads will be resurfaced with aggregate and the slopes reseeded (except for erosion protection areas). Construction requires that the waterside crest edge be cleared grubbed, and stripped of 0.5-2 ft of material. The landside slope and crown will be scraped or ripped and the raise material will then be placed and compacted. Heavy equipment such as a hitched scraper, disc, or ripper will be used to loosen material. Other typical equipment will involve a water truck, grader, dump trucks, bulldozer, and compaction equipment.

Floodwall

This measure will consist of a sheetpile floodwall from the southern portion of Dad's Point to Louise Park, about 3-4 ft high, possibly with a metal cap or encased in concrete, and 12-18 inches wide. The extent will be 825 ft in length. The improvement at this location may be a berm instead of a floodwall.

New Levee

This measure involves constructing a new levee to reduce risk to some areas or prevent outflanking the existing levee system. A new levee is planned for a portion of Duck Creek to tie into existing levee. Construction will involve clearing and grubbing the footprint area, and excavating a new foundation 3-6 ft deep. Material will be placed and compacted in short lifts. A gravel road will be constructed on the crown and slopes will be reseeded. The BA states that cutoff wall and erosion protection will be placed if needed, however, erosion protection at Duck Creek has since been deleted (see Consultation History). Equipment for new levee will be similar to that for levee raise.

A short earthen berm, which will be constructed and function similar to a new levee, may be constructed in lieu of the floodwall proposed near Dad's Point to high ground at Louise Park as part of the Smith Canal improvements. No construction details of this berm are currently available. The linear extent will also be about 825 ft, but the footprint width may be wider.

Closure Structure

This measure will involve construction of structures across Smith Canal and Fourteenmile Slough to prevent flooding from the San Joaquin River and Delta; for Fourteenmile Slough, it also will limit the level and duration of water saturation due to higher tides on private levees to the east to reduce the risk of their failure. Each structure will consist of a fixed sheet pile wall structure with an opening gate structure to allow tidal flows and boats to pass when open. A small building has been specified for the Smith Canal structure but since the Fourteenmile

Slough structure is a separate, scalable version, it may also require a building. The structure will tie into high ground, either the new berm for the Smith Canal structure or the levee for the Fourteenmile Slough structure. The structures will be routinely closed during any water stage equal to or greater than 8 ft North American Vertical Datum of 1988 (NAVD88) caused by high tides or high tide in combination with rain on snow flood events, as well as during emergency (e.g., failure along Smith Canal and Fourteenmile Slough levees to the east) (see Operation and Maintenance, below). The frequency and duration of gate closure operation is expected to increase during wetter water years, and over the life of the project due to sea level rise.

For portions of the sheetpile to be installed on land, vegetation will be cleared and grubbed for a 35-ft-wide footprint. For the portions of the sheetpile to be installed in water, installation will be done in water using a barge and tug boat. The structure will consist of two parallel sheetpile walls 20 ft apart. The space between the walls will be dewatered and filled with granular fill. Installation of the gate structure and its foundation will be done in the dry by constructing a metal sheet cofferdam for a 70 x 70 ft area. This area will be dewatered. Concrete cylinder piles (24 inch) will be driven inside the cofferdam, then concrete walls and floor, and then the metal miter gate. The gate for each structure will be 50 ft long. Equipment will include a barge, tugboat, vibratory hammer, crane, and vehicles for transporting equipment, material, and personnel.

<u>Erosion Protection</u>

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History).

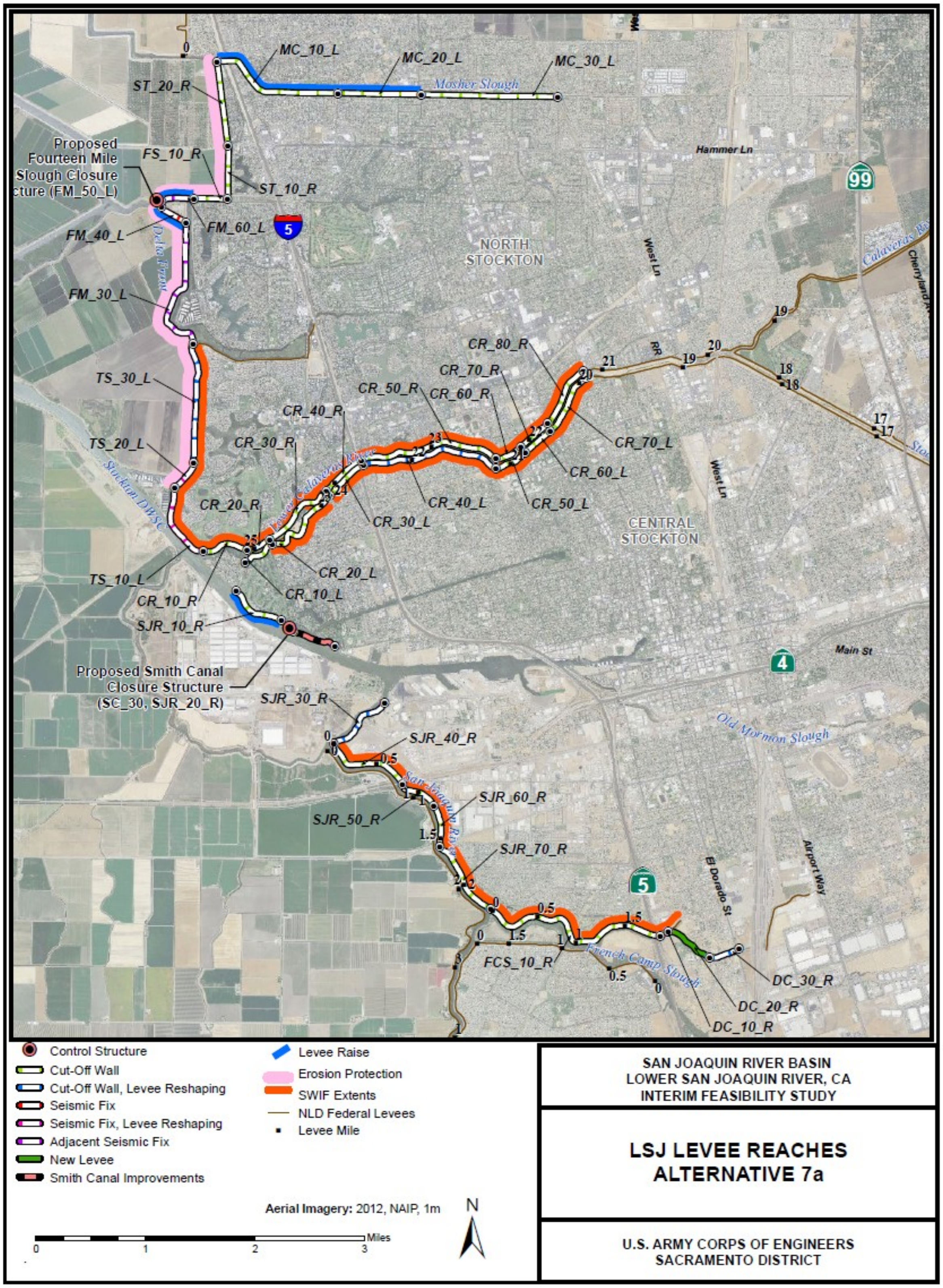
Conventional quarry stone riprap is proposed. A sand filter will be installed prior to riprap placement. Equipment used will be dump or belly dump truck, dozer, and hydraulic excavator. The riprap will be placed in a two-foot-thick layer along the full face of the levee from toe to crown.

A summary of the construction measures in each reach under the proposed plan (alternative 7a in the Feasibility Study) is provided in Appendix A and is depicted in Figure 1.

ETL Compliance Activities:

Additionally, the project includes treating encroachments either by removal, relocation, or otherwise bringing them into compliance with Corps policy. This includes structures, certain vegetation, power poles, pumps, and penetrations. The project also includes establishment of ETL compliant levees. ETL standard compliance is achieved by removal and maintaining free of woody vegetation the entire levees, floodwalls, and easements 15 ft landward and waterward beyond the levee toe or floodwall footing. A variance from the ETL standard may be considered after detailed engineering analysis which may allow some vegetation to remain if the analysis demonstrates that such vegetation does not imperil the levee. This analysis has not yet been done. However, based on the information available at the time of initiation of this formal consultation, the Corps expects that all vegetation shall be required to be removed from the entire

Figure 1. Lower San Joaquin River Feasibility Study Recommended Plan



landside slope and easement, and from the upper half of the water side slope. For the lower half of the water side slope and easement, the Corps expects that with an approved variance, up to 75% of the current vegetation cover shall be removed and at least 25% of this current vegetation will remain. Up to 50% of the vegetation on the lower waterside slope may be allowed to remain depending on the future project refinement and analysis. The amounts of removed and retained vegetation by reach have been estimated (see Consultation History: April 13, 2016 and Appendix B). These estimates of vegetation removal are based on projected canopy area.

The Corps anticipates it will formulate additional specificity in the vegetation maintenance prior to construction, as part of its variance request process and development of an operation and maintenance manual consistent with any approved variance. These will include necessary limitations in the basal diameter of woody vegetation, spacing between vegetation for purposes of inspection sight lines and flood fighting, and plant species. This variance will be requested and obtained prior to construction. Although the Corps expects that some vegetation will be allowed, it will likely differ in stature from the existing vegetation in some locations. Non-native trees, including nut trees, will probably be removed, as will large diameter trees generally, and not allowed to regrow. Stem or basal diameter sizes of remaining trees, and those which will be allowed in the future, will likely be limited to 8 inches or less. Vines and brambles will probably be removed entirely. The initial treatment of encroachments and vegetation will be done (and in some cases must be done) concurrent with construction, and is therefore considered part of the construction phase.

Operation and maintenance activities:

The project includes the continued operation and maintenance of the facilities after construction. Activities performed for operation and maintenance and their effects on listed species are covered by this consultation. The Corps is responsible for amending the operation and maintenance manual for levees and other facilities affected or created by the project, also referred to as the Operation, Maintenance, Repair, Replacement and Rehabilitation manual (OMRRR). The local sponsor to whom the project will be transferred will be required to implement the OMRRR. Generally, the levees will be required to be maintained to the as-built condition in perpetuity. This will require regular inspection, identification of any deficiencies, and implementation of actions. The type of actions will include: geometric adjustment due to any settlement (irregular, as needed); vegetation maintenance up to four times a year including mowing, removal or trimming of vegetation, and/or application of herbicide; patrol road maintenance; visual inspections; trash and debris removal as needed; invasive aquatic weed control and application of herbicide and mechanical removal; grouting of animal burrows; monitoring and protection of interior features (cutoff walls, jet grouting, seismic remediation) from encroachments or other ground disturbing activities; inspection and repair of floodwalls; and routine maintenance and repair as needed of the two closure structures. Only those activities within the footprint and easements of the improvements described in the LSJRFS are covered in this biological opinion. Activities in the channel such as silt removal, aquatic weed control, and/or removal of vegetation or other materials will require separate consultation.

There are also existing operation and maintenance requirements for the channels associated with the proposed improvements which could affect the snake. Specifically, the Calaveras River from the San Joaquin River upstream to McAllen Road, which includes a number of reaches of this proposed project, is part of the Mormon Slough Project. The existing OMRRR for that project requires inspections and maintenance of any shoaling or debris that affects floodway capacity, including (p. 22, Mormon Slough Project OMRRR) "weeds and other vegetal growth in the channel shall be cut in advance of flood season and together with all debris, removed from the channel" and (p. 23) "during periods of high water...Appropriate measures shall be taken to prevent the formation of jams of debris." Portions of the project channels appear to be at least partially maintained (e.g., Calaveras River, North Pershing Ave. to El Dorado Street), while others appear in a more natural state (e.g., Calaveras River west of North Pershing Avenue; French Camp Slough).

There is insufficient description of channel maintenance to evaluate effects on listed species at this time. Accordingly, channel maintenance and effects thereof on listed species are not considered nor authorized in this biological opinion. Only those OMRRR activities within the footprint and easements of the improvements described in the LSJRFS are covered in this biological opinion. As necessary, the Corps will consult separately or re-initiate consultation for effects of channel maintenance such as silt removal, aquatic weed control, and/or removal of vegetation or other materials.

Conservation Measures:

The following general, avoidance and minimization, and compensation measures shall be implemented:

General Measure

- Overall construction affecting habitat of any listed species will be scheduled and sequenced to the minimum period necessary to complete the work, generally, 3 years for the Central Stockton area reaches (2018-2020) and 8 years for the North Stockton area reaches (2021-2028). Should the work period differ in either timing or duration by more than 5 years from these periods, the Corps shall re-initiate consultation.

Delta Smelt

Construction Phase:

Avoidance and Minimization Measures

- Implement best management practices (BMPs) to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110% containment system.
- Implement erosion control measures (BMPs) including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. Install and monitor BMPs for effectiveness, and

maintain BMPs throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.

- Schedule construction when smelt will be least likely to occur in the project area. Complete avoidance will be assumed if in-water work is completed between August 1 and November 30. However, the Corps anticipates the need to begin in-water work on the gates for the two closure structures as early as July. Since construction needs to extend into the timeframe when smelt may be present, the Corps will develop and submit to the Service prior to construction, a fisheries protection plan that includes measures and monitoring, and/or additional compensation, to offset the effect of this in-water work on smelt.
- Limit site access to the smallest area possible in order to minimize disturbance.
- Remove litter, debris, unused materials, equipment, and supplies from the project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
- Immediately (within 24 hours) clean up and report any spills of hazardous materials to the resource agencies. Report any such spills, and the success of the efforts to clean them up, in post-construction compliance reports.
- Designate a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped, threatened or endangered species. Identify this representative to the employees and contractors during an all employee education program conducted by the Corps.
- For work between December 1 and July 31 that involves pumping, screen any water pump intakes as specified by Service screening specifications. Water pumps will maintain flows to keep approach velocity at the pump screens at 0.2 ft per second or less when working in areas that may support delta smelt or juvenile salmonids.

<u>Compensation Measures</u>

- The Corps proposes to offset the permanent open water impact of an estimated 1 acre, due to construction of the two closures structures by purchase of 3 credits (acres) at a Service-approved conservation bank.
- The Corps proposes to offset the effect of operation of the closure structures on tidal action in an estimated 233 acres combined in Fourteenmile Slough and Smith Canal by purchase of 120 credits (acres) at a Service-approved conservation bank.

<u>Giant Garter Snake</u>

Construction Phase:

<u>Avoidance and Minimization Measures</u>

- For each discrete reach affecting snake habitat, construction will be initiated during the snake active period (May 1–October 1) and prior to September 15, but may continue beyond the active period provided that work is continuous (lapses shall be no greater than 24 hours).

- All construction personnel, including workers and contractors, will participate in a worker environmental awareness training program conducted by a Service-approved biologist prior to commencement of construction activities.
- Reach specific monitoring and inspection will be conducted appropriate to the potential for snake presence as indicated by the proximity to and quality of habitat. This will include one or more of the following measures as specified in Appendix A: (a) a pre-work inspection sufficient to detect active snakes before any construction, to occur no sooner than 24 hours prior to initial construction in potential habitat; (b) a morning inspection before each work day, including the work site, and any parked equipment; (c) an additional second inspection of habitat during construction for each work day; (d) continuous[2] monitoring during all work; and/or (e) a choice of either exclusionary fencing in those reaches where it is possible (i.e., Calaveras River from North Pershing to El Dorado St.; Duck Creek work) or continuous monitoring. Should there be any interruption in work for greater than two weeks, a biologist will survey the project area again no later than 24 hours prior to the restart of work.
- If the Corps elects to use exclusionary fencing in lieu of continuous monitoring, it will be buried at least six inches below the ground to prevent snakes from burrowing and moving under the fence, and will be inspected daily.
- Snakes encountered during construction activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas; where possible, these will be located more than 200 ft away from snake aquatic habitat.
- Snake habitat within 200 ft of construction activities will be designated as an environmentally sensitive area and delineated with signs and high visibility fencing. Fencing will be inspected and maintained as needed daily until completion of each work section of the project. This area will be avoided by all construction personnel.
- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out will be determined, and the frac-out will be monitored for hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- The Service, National Marine Fisheries Service, California Department of Fish and Wildlife, and the Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be onsite and used if a frac-out occurs. Containment materials, such as straw bales, also will be onsite prior to and during all operations, and a vacuum truck will be on retainer and available to be operational onsite within notice of 2 hours. The site

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[2] "Continuous monitoring" means that an approved monitor is conducting continuous visual examination for snake presence throughout the workday within and immediately adjacent to work sites. Monitoring protocols are not specified at this time and are subject to Service approval.

supervisor will take anynecessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks) as needed.

- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1ft, contained, and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.

- Project-related vehicles will observe a 20-mile-per-hour speed limit within construction areas, except on existing paved roads where they will adhere to the posted speed limits.

- Aquatic habitat for the snake which will be affected by construction will be inspected for the snake, then dewatered, and maintained dry and absent of aquatic prey for 5 days prior to the initiation of construction activities. This measure applies primarily to the ditches to be relocated west of the Delta front levee sections. If complete dewatering is not possible, the Service will be contacted to determine if any additional measures may be necessary to minimize effects to the snake.

Compensation Measures

- Habitat (primarily upland) temporarily impacted for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants. This includes 111.5 acres of upland snake habitat primarily between the edge of the levee crown to the waterside easement of work locations (excludes hard surfaces) impacted by cutoff wall, seismic fix, levee raise, and/or reshaping actions; all temporary fill and construction debris shall be removed prior to such restoration work. Landside aquatic habitat consisting of ditches on the Delta Front reaches are considered temporarily impacted because they will be re-created west of the new setback levee there.

- Aquatic habitat permanently impacted will be replaced at a 3:1ratio. This includes the portion of the permanent closure structure at Fourteenmile Slough. The estimated area of permanent impact is considered to be no more than 0.5 acre, for which the Corps will provide no more than 1.5 acres of compensation at an approved mitigation bank.

- Upland habitat permanently impacted will be replaced at a 1:1ratio. This includes an estimated 12.5 acres (footprints of the permanent closure structure at Fourteenmile Slough, new road surfaces on the Duck Creek levee, and landside armoring along Fourteenmile Slough). The Corps will provide up to 12.5 acres of compensation at a Service- and Corps-approved mitigation bank.

- Animal burrows exist throughout the project footprint (includes easements). These burrows are a special element of upland habitat used by the snake as refugia. Animal burrows in the footprint will be removed or filled as part of construction activities and new animal burrows will be subject to grouting throughout the project life as part of operation and maintenance. To offset the effect on the snake of construction and grouting of animal burrows for all reaches of the project considered potential snake habitat, there will be a one-time purchase of 22.62 snake credits at an approved snake conservation bank before any project construction[3].

- The Corps will ensure that mitigation is acquired prior to any disturbance of snake habitat. Habitat will be protected, managed, and maintained, in perpetuity.
- Quantify alternative snake refugia (i.e., alternatives to animal burrows, consisting of upland features within 30 ft of snake aquatic habitat, including but not limited to brush piles; riprap with voids sufficient to allow snake use; animal burrows in uplands outside of maintenance zones but within levees, including islands). This assessment will be done within one year prior to the initial onset of project work, and repeated at five year intervals until completion of all project work in the LSJRFS.

Operation and Maintenance Phase:

Avoidance and Minimization Measures

- Snake-impacting OMRRR activities will be planned so that they occur between May 1 and October 1 during the snake's active season so as to minimize impacts to the species.
- Grouting of animal burrows on upland within 30 water side ft of snake aquatic habitat will only be done between May 1 and September 1, and during times of day when air temperatures are between 13 and 34 degrees Centigrade (55.4 and 93.2 Fahrenheit). Grouting will be permitted without restriction on levee road and ramp road surfaces, on the land side of the levee, and on upland farther than 30 ft from the water side.
- Construction personnel will participate in Service-approved worker environmental awareness program.
- A snake survey will be conducted 24 hours prior to beginning OMRRR activities in potential habitat. Should there be any interruption in work for greater than two weeks; a biologist will survey the project area again within 24 hours of restarting work.
- Snakes encountered during OMRRR activities will be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from construction associated with OMRRR will be restricted to established roadways. Stockpiling of construction materials will be restricted to designated staging areas, which will be located more than 200 ft away from snake aquatic habitat.

Valley Elderberry Longhorn Beetle

Construction Phase:

[3] 22.62 credits = Length sum of 54,750 ft (reaches Calaveras reaches CR_30_R, CR_40_R, CR_50_R, CR_60_R, CR_70_R, CR_80_R, CR_10_L, CR_20_L, CR_30_L, CR_40_L, CR_50_L, CR_60_L, CR_70_L; French Camp Slough reach FCS_10_R; and Duck Creek reaches DC_10_R, DC_20_R, and DC_30_R) X 30 ft X 0.2 (factor of 20% reduction in snake upland quality due to summer grouting assumes that some non-burrow refugia habitat, or ephemeral burrows between maintenance inspection/actions, will remain, and that a variance is approved)/43,560 square ft per acre x 3 (3:1 ratio of compensation:effects).

Avoidance and Minimization Measures

The following measures based in part on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS 1999; hereafter "Conservation Guidelines") will be implemented to minimize any potential effects on beetles or their habitat, including restoration and maintenance activities, long-term protection, and compensation if shrubs cannot be avoided:

- When a 100 ft (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-ft buffer has been approved by the Service, a setback of 20 ft from the dripline of each elderberry shrub will be maintained whenever possible.
- Shrubs that are closer than 100 ft to any work, but outside the construction footprint (construction, ETL compliance, OMRRR) are assumed to be avoided by the application of other avoidance measures such as signage, fencing, worker education, and post-construction monitoring that demonstrates no effect on health and viability (see compensation measures, below), and will not be subject to transplantation or the need for offset compensation.
- During construction activities, all areas to be avoided will be fenced and flagged.
- Contractors and work crews will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs will be erected every 50 ft along the edge of the avoidance area identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area will be restored.
- Buffer areas will continue to be protected after construction from adverse effects of the project, such as during maintenance actions.
- No insecticides, herbicides, fertilizers, or other chemicals that might harm the beetle or its host plant will be used in the buffer areas.
- Trimming of elderberry plants is subject to mitigation measures.
- Elderberry shrubs that cannot be avoided will be transplanted to an appropriate riparian area at least 100 ft from construction activities or to an approved conservation bank.
- Elderberry shrubs to be removed will be transplanted during their dormant season (November 1-February 14).
- Any areas that receive transplanted elderberry shrubs and elderberry cuttings will be protected in perpetuity.
- The Corps will work to develop and identify on- and off-site compensation areas prior to any take of beetles.
- The Corps will submit its site suitability study to the Service for review and comment prior to implementation; and request and receive written concurrence from the Service that the site(s) is suitable for compensation for this project prior to construction.

- Management of compensation areas will include all measures specified in the Conservation Guidelines related to weed and litter control, fencing, and the placement of signs.
- Monitoring of compensation areas will occur for five consecutive years. Annual monitoring reports will be submitted to the Service.
- Dust control measures shall be implemented when construction activities take place within 100 ft of elderberry shrubs.
- Off-site compensation areas will be protected in perpetuity and have a funding source for maintenance.

Compensation Measures

Compensation for landside and waterside effects to the beetle will be addressed in accordance with the Conservation Guidelines under the presumption that effects on shrubs outside of the footprint (construction and easement areas) will be avoided by application of conservation measures. Removal of elderberry shrubs in the footprint to be transplanted would occur prior to construction during dormancy. Transplants and compensatory seedlings and associated native plants would be planted at a Service and Corps approved site, which could include the compensation area described below, or other suitable sites not yet identified. If another site other than that described is proposed, the Corps will coordinate with the Service through reinitiation of formal consultation.

The proposed compensation area for the beetle is within the seismic remediation area with setback located on Fourteenmile Slough cost reach FM_30_L (Figure 1). The plantable area will include land from the degraded levee (i.e., including the degraded levee as plantable) to the edge of the new levee easement. Based on the affected number of stems, the Corps proposes to plant 196 plantings (Table 1). This is based on the continued survival of the 18 shrubs which are near (but not within) the footprint area. To document that avoidance measures are effective in protecting these shrubs, the Corps will assess their health and condition no sooner than the season prior to construction at that location, and for 2 years following completion of the construction. Shrubs which die or show a major decline in condition during this period will be compensated offsite in accordance with the Conservation Guidelines.

Operation and Maintenance Phase:

The avoidance, minimization, and compensation measures described here are examples of the types of measures that may be appropriate during the operation and maintenance phase of the project.

Avoidance and Minimization Measures

When a 100-ft (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.

- Where encroachment on the 100-ft buffer has been approved by the Service, a setback of 20 ft from the dripline of each elderberry shrub will be maintained whenever possible.

- During maintenance activities, all areas to be avoided will be fenced and flagged.
- Maintenance personnel will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Dust control measures shall be implemented when OMRRR activities take place.
- Maintenance workers will be trained on identification of elderberry plants.
- No restrictions or measures are required for areas which are to be maintained free of any woody vegetation; it is assumed these areas will be maintained on an interval such that any elderberry plants will not achieve the minimum 1 inch necessary for potential beetle occupation.

Table 1: Elderberry Compensation Worksheet for the Lower San Joaquin River Feasibility Study.

Affected elderberry plant compensation ratios based on location, stem diameter, and presence of exit holes

Worksheet			**No. of Stems**	**elderberry ratios**	**elderberry planting**	**associated native planting**	**native ratios**
Location	**stems**	**Holes present?**		**multiplier (ratio)**			
non-riparian	greater than or = 1" & less than or = 3"	No	**27**	1	27	**27**	**1**
non-riparian	greater than 3" & less than 5"	yes	**0**	2	0	**0**	2
	greater than 3" & less than 5"	No	**7**	2	14	**14**	1
non-riparian	greater than or = 5"	yes	**0**	4	0	**0**	2
	greater than or = 5"	No	**6**	3	18	**18**	1
riparian	greater than or = 1" & less than or = 3"	yes	**0**	6	0	**0**	2
	greater than or = 1" & less than or = 3"	No	**39**	2	78	**78**	1
riparian	greater than 3" & less than 5"	yes	**0**	4	0	**0**	2
	greater than 3" & less than 5"	No	**9**	3	27	**27**	1
riparian	greater than or = 5"	yes	**0**	6	0	**0**	2
	greater than or = 5"	No	**8**	4	32	**32**	1
Totals			**96**		**196**	196	

- For reach areas with approved vegetation variances and planned for maintenance, elderberry bush surveys will be done prior to and in the same season as maintenance, identifying the number of elderberry bushes and stems by diameter size class, and noting any exit holes or live beetles observed (see Table 1 for information format).

After construction, elderberry plants may establish or re-establish in project reach areas that will be subject to routine OMRRR activities (i.e., other than compensation area(s)). Areas with approved variances could support elderberries with stem sizes larger than the minimum 1 inch considered potentially occupied by the beetle. These may require removal and/or trimming of elderberry plants. The proposed measures for these types of OMRRR activities are as follows:

- Trimming of an elderberry bush will be allowed without compensation provided it removes no more than one-third of either the total stem diameter of stems >1 inch, or the projected canopy area of that bush.
- Removal of entire bushes will be allowed without compensation provided the action removes no more than one-half of the number of bushes in a reach with equivalent or lessor combined canopy area than those remaining.
- Trimming of bushes will be allowed no more frequently than every third year.
- Trimming or removal of bushes will be done between July 1 and February 28.

<u>Compensation Measures</u>

- Trimming in excess of the one-third allowance will involve compensation at a Service-approved site of two elderberries and one associated planting for every bush excessively trimmed, provided that the over trimmed bush is determined to have survived to the following season.
- Excessively trimmed bushes will be inspected for vitality the season following; if the over trimmed bush is dead, it will be assessed for stem diameter losses and compensated in accordance with the Conservation Guidelines.
- Removal of entire bushes in excess of the one-half allowance will be compensated in accordance with the Conservation Guidelines.

<u>Additional Minimization and Conservation Measures (all listed species)</u>

To further avoid and minimize project effects on listed species and their critical habitat the Corps will conduct the following additional measures during the Preconstruction Engineering and Design (PED) phase, and prior to construction:

- Evaluate the suitability of the levees for an ETL 1110-2-583 vegetation variance. Where suitable, pursue a vegetation variance that would allow woody vegetation to remain on the lower waterside portion of the levee and within the 15ft waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements. It is anticipated that a vegetation variance, if approved, will allow at least 25% of the woody vegetation, as measured by projected area, to remain on the lower waterside portion of the levee and within the 15ft waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements, floodwall, or closure structures), in each reach. This consultation request applies solely to the circumstance in which a variance is approved in advance of construction. If a variance is not sought, or not approved, the Corps will reinitiate consultation.

- Develop the information necessary to evaluate the feasibility of establishing Shaded Riverine Aquatic (SRA) and shallow water habitat compensatory mitigation outside of the vegetation-free zone (or within it where a vegetation variance is approved) along the Lower Calaveras River.
- Minimize vegetation removal to the extent feasible.
- Minimize, to the extent possible, grubbing and contouring activities.
- Identify all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporate sensitive habitat information into project bid specifications.
- Incorporate requirements for contractors to avoid identified sensitive habitats into project bid specifications.
- For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service, a pre-construction accounting of the actual amount of listed species habitat expected to be temporarily and permanently affected by the project, and proof of the acquisition or completed construction of any required compensation habitat needed to offset these effects.
- The Corps will reinitiate consultation during the Preliminary Engineering and Design (PED) phase if there are changes in effects to listed species due to design refinements.

Action Area

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area includes all areas where any type of construction, ETL compliance action, or operation and maintenance action will occur; staging areas and transportation routes used for this construction (not specified at this time); areas to the east of the two closure structures where tidal exchange will be limited by operation of such structures (i.e., Fourteenmile Slough and Smith Canal); the portion of Fourteenmile Slough to the west of the proposed closure structure, where local tidal exchange will also be affected; and the setback area in reach FM_30_L designated for mitigation plantings; and any other mitigation bank sites deemed necessary to offset impacts (i.e., approved conservation banks, not specified at this time).

Analytical Framework for the Jeopardy Determination

In accordance with policy and regulation, the jeopardy analysis in this biological opinion relies on four components for the snake, beetle, and smelt: (1) the *Status of the Species*, which evaluates the species' range-wide condition, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which evaluates the condition of species in the action area, the factors responsible for that condition, and the relationship of the action area to the survival and recovery of the species; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the species; and (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the species.

In accordance with policy and regulation, the jeopardy determination is made by evaluating the effects of the proposed Federal action in the context of the species' current status, taking into account any cumulative effects, to determine if implementation of the proposed action is likely to cause an appreciable reduction in the likelihood of both the survival and recovery of these species in the wild.

The jeopardy analysis in this biological opinion places an emphasis on consideration of the range-wide survival and recovery needs of these species and the role of the action area in the survival and recovery of these species as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the jeopardy determination.

Analytical Framework for the Adverse Modification Determination

This biological opinion does not rely on the regulatory definition of “destruction or adverse modification” of critical habitat at 50 CFR 402.02. Instead, we have relied upon the statutory provisions of the Act to complete the following analysis with respect to critical habitat.

In accordance with policy and regulation, the adverse modification analysis in this biological opinion relies on four components: (1) the *Status of Critical Habitat*, which evaluates the range-wide condition of critical habitat for the delta smelt in terms of primary constituent elements (PCEs), the factors responsible for that condition, and the intended recovery function of the critical habitat at the provincial and range-wide scale; (2) the *Environmental Baseline*, which evaluates the condition of the critical habitat in the action area, the factors responsible for that condition, and the recovery role of the critical habitat in the action area; (3) the *Effects of the Action*, which determines the direct and indirect impacts of the proposed Federal action and the effects of any interrelated or interdependent activities on the PCEs and how that will influence the recovery role of affected critical habitat units and; (4) *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the action area on the PCEs and how that will influence the recovery role of affected critical habitat units.

For purposes of the adverse modification determination, the effects of the proposed Federal action on the delta smelt critical habitat are evaluated in the context of the range-wide condition of the critical habitat at the provincial and range-wide scales, taking into account any cumulative effects, to determine if the critical habitat range-wide will remain functional (or will retain the current ability for the PCEs to be functionally established in areas of currently unsuitable but capable habitat) to serve its intended recovery role for the delta smelt.

The analysis in this biological opinion places an emphasis on using the intended range-wide recovery function of delta smelt critical habitat and the role of the action area relative to that intended function as the context for evaluating the significance of the effects of the proposed Federal action, taken together with cumulative effects, for purposes of making the adverse modification determination.

Status of the Species and Environmental Baseline

Delta Smelt Status of the Species

For information on the status of delta smelt, please see our most recent 5 year review and 12 month finding for delta smelt (Service 2010a, b). We found that the status of the species warrants reclassification from threatened to endangered, but that this reclassification is precluded by higher priority actions.

Status of the Delta Smelt Critical Habitat

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code). The Primary Constituent Elements (PCEs) are physical habitat (PCE#1), water (PCE#2), and river flow (PCE#3).

Delta Smelt and Critical Habitat Environmental Baseline

The action area of the proposed project includes tidal waterways of the Delta that are wholly within critical habitat for the species. Adult delta smelt will be expected to migrate from the western Delta into these waterways in the winter and spring months, with typical spawning occurring during April through mid-May, but the species may be present as early as December. Larval smelt will move west in the spring and summer and rear in the low salinity zone. The action area includes shallow subtidal waters that can be used by the species. The project area also includes adjacent levees and vegetation; however, the quality of that habitat for smelt varies with location within the project area and the immediate vicinity. Some portions of the project area include heavily armored channels with limited vegetation on levee slopes or in adjacent shallow water. Other parts of the project area have less armoring and more vegetation growing on the levee slopes. Portions of the action area consist of shallow subtidal waters interspersed with emergent marsh vegetation adjacent to the proposed work; this includes fragments throughout the project area, as well as larger habitat blocks on Fourteenmile Slough both east and west of the proposed closure structure, on the lower Calaveras River, and on French Camp Slough.

The overall numbers of delta smelt have dramatically declined in the last 10 to 15 years, and the species population has fallen to very low numbers during the most recent drought period (2011-2015). The Fall Midwater Trawl index (FMWT) fell to a record low of 7 for 2015 after a previous record low of 9 in 2014 (CDFW 2016). By comparison, the prior historical low of the FMWT was 17 in 2009, down from a recent increase in the FMWT to 343 in 2011.

Delta smelt observations have been recorded in the California Natural Diversity Database (CNDDB) along the mainstem San Joaquin River within the project area as recently as 2004, and more recent records are known to the north and west on waterways contiguous to the project area including Little Potato Slough, the Mokelumne River, Frank's Tract, and Empire Cut. Adult and larval delta smelt have also been captured in the near vicinity of the project area. Because of the presence of the primary constituent elements needed for delta smelt spawning, the location of the project area within critical habitat, and the existence of known records, we conclude that delta smelt are present in the action area.

Giant Garter Snake Status of the Species

For the most recent Service assessment of the species' range-wide status, please refer to the *Giant Garter Snake (Thamnophis gigas) 5-year Review: Summary and Evaluation* (Service 2012). It is the largest garter snake species and endemic to the Central Valley. Ongoing threats to giant garter snake include habitat loss from urbanization, the resultant fragmentation and population isolation, flood channel maintenance, agricultural practices (e.g., rice fallowing due to drought conditions, habitat disturbance and loss from irrigation and drainage ditch maintenance), climate change, water transfers, and invasive species. Our review emphasizes urbanization as one of the greatest threats to the species, particularly where associated with rice agriculture. While these threats continue to affect the giant garter snake throughout its range, to date no project has proposed a level of effect for which the Service has issued a biological opinion of jeopardy for the giant garter snake.

According to Halstead et al. (2015a), habitat quality plays a central role in the population ecology of this species, depending on factors like refuge and prey availability, vegetation type and density, and scouring floods. Our revised draft recovery plan outlines actions needed to protect and enhance the species sufficiently to remove it from the list of endangered species (USFWS 2015). This includes but is not limited to, the protection, connection, and improvement of the quality and presence of habitat through various management actions aimed at water quality and presence of summer water.

More recent studies examining the use of uplands have bearing on the effects of the proposed project (Halstead et al. 2015b). It has been known for some time that the giant garter snake spends half of the year, roughly November through April, hibernating in uplands. However, it is now known that the snake also spends more than half the time in terrestrial environments during the active period during summer. While in such terrestrial habitats in summer, the snake is often underground, especially during extreme temperatures. Animal burrows are believed to be an important component of upland refugia, although other elements such as brush piles and even riprap may be used (e.g., Wylie and Amarello 2008). Although snakes can venture as much as 500 ft or more from the water edge, the overwhelming majority of both the summer and winter upland captures are within the first 10 meters from the water edge.

Giant Garter Snake Environmental Baseline

Most information on the status of the snake comes from work on agricultural and managed refuge lands; much less is known about the snake outside of these areas in other habitats. Nevertheless, scattered records documented on the CNDDB indicate a wider distribution that includes marshes and waterways of the Delta, which includes and is hydrologically connected to the proposed project area. Other than historic records, the nearest post-development sightings to the project area are both from 1976: the Stockton Diverting Canal, about 2.7 miles away, which connects to the Calaveras River, and Pixley Slough, about 2 miles away. More recent (i.e., up to 2010) and frequent sightings have been recorded in the White Slough Wildlife Area, about 4-6 miles to the north of the project area. A few snakes have also been documented on lands near major waterways in the western Delta as recently as 2016, including the Sacramento River (Sherman Island), Frank's Tract (Webb Island), Twitchell, Jersey and Bradford Islands, and the San Joaquin River (Little Venice Island). In the Little Venice Island sighting in 1996, several snakes were seen, including one which moved into riprap. The project area includes permanent waters with varying amounts of aquatic vegetation and adjacent uplands which could potentially support the snake (Appendix A). The distribution of the snake and range of habitat types in which it has been observed, lead us to conclude that the snake is present in the project area.

Valley Elderberry Longhorn Beetle Status of the Species

The Service designated the beetle as threatened and proposed critical habitat on August 8, 1980 (45 FR 52803) and approved a final Recovery Plan on June 28, 1984. A 5-year review was completed on September 26, 2006, which determined that the beetle had recovered and therefore recommended delisting. A proposed rule to delist the beetle was published on October 12, 2012 (77 FR 60237). After public comment and peer review, that proposal was withdrawn on September 17, 2014 (79 FR 55879).

This wood boring beetle is a subspecies of the California elderberry longhorn beetle which persists in small isolated populations in the California Central Valley in riparian areas which have a component of elderberry savannah. The listed subspecies is typified by sexual dimorphism, in which the male shows a predominantly red elytra. The primary threat to the species is habitat loss, particularly along major river systems that are known to have supported the species, often as a result of urban or agricultural development and flood control actions (both construction and operation and maintenance). Additional major threats are that of extinction due to small population size, predation from alien species such as the Argentine ant, inadequate protections (other than the Endangered Species Act), pesticides, non-native plants of various types that compete with native riparian vegetation including elderberries, and other factors. The beetle itself is rarely seen, and the vast majority of its detection reported in the CNDDB have been inferred from the presence of exit holes in plant stems.

The period since listing to the present has witnessed considerable population and urban growth in California at the expense of remaining riparian habitat and adjacent upland habitat near river systems that supported elderberry. Elderberry plants can colonize and persist on levees and nearby lands as well, and some beetle and exit hole records have been reported in this type of habitat. This form of habitat is often the result of deferred maintenance. However, Federal flood control improvements including the currently proposed project, as well as State-wide initiatives to improve the standard of flood control in urban systems generally, have resulted in levee improvements and more rigorous maintenance that has eliminated this habitat. Mitigation is typically done off-site in banks, and habitat enhancement has been almost entirely limited to Federal and State refuge lands in the north Central Valley. In sum, since listing, there has been a progressive further decline in beetle habitat amount and distribution with increasing discontinuity between remaining habitat fragments, reduced frequency of sightings, and likely curtailment of the range of this species.

Valley Elderberry Longhorn Beetle Environmental Baseline

Most of the records of adult beetles date from the 1980s and 1990s or earlier. With the exception of recent pheromone trials on a Service refuge that yielded ~20+ captures in 2014, only about a dozen other beetle specimens have been seen anywhere in the last 15 years, and the majority of these were in conservation areas on Federal or State lands or conservation banks in the North Central Valley. In the proposed project vicinity, a sighting of adult beetles (including a male) in 1984 has been reported near Middle River, about 4.5 miles west of the nearest proposed project feature. In the region, there were several beetle exit holes detected along the Calaveras River near Linden, roughly 8 miles east of the project area, and along Bear Creek near Lockeford, about 15 miles north of the project area, all in 1984. Upon re-examination in 1989 by Barr (1991), these particular vicinity locations no longer supported beetles nor live elderberry plants. Other studies of formerly occupied areas of both South and North Central Valleys have shown complete loss of elderberry plants, negative surveys for beetle holes, or very low occupancy (Collinge et al. 2001; Kucera et al. 2006; River Partners 2007; Holyoak and Graves 2010).

The project area includes potential habitat for the species which will be affected by the proposed action. Woody vegetation of variable densities is present throughout the project area, depending on the extent and intensity of maintenance of the current levees. Based on surveys conducted in 2015 (BA pp. 72-74), the Corps estimates that up to 44 elderberry shrubs could be affected by the proposed project (i.e., in the footprint or within 100 ft of the project footprint boundary). These elderberry shrubs are located along certain project reaches of Tenmile Slough, the Calaveras River, and the San Joaquin River. The plants include stems larger than 1 inch and some greater than 5 inches, indicating a size sufficient to support the beetle. Because of the presence of shrubs, location in or near riparian habitats, and documented records of beetles and exit holes in the region, we conclude that the beetle is present in the project area.

Effects of the Action

Delta Smelt

For the purposes of this consultation, Shallow Water Habitat (SWH) - that habitat which is assumed to be usable by delta smelt and for which direct effects may occur - is bounded by an upper limit at mean high water, and a lower limit 3 meters below mean lower low water.

Construction along portions of the project subject to levee reshaping may require removal and replacement of water side revetment. Such levee reshaping is specified for mainstem San Joaquin River reach SJR_30_R (3,500 lineal ft) and the south (left) bank of the lower Calaveras River at reach CR_40_L (6,900 lineal ft). BA Figure 5 shows the corrective method to involve placing additional material on the land side, while BA text (p. 17) states that some existing levees with slopes as steep as 2:1 "may be acceptable if slope performance has been good and if the slope stability analyses determined that factors of safety to be adequate." No such analyses are yet available. It is undetermined at this time what if any waterside revetment may be placed (or replaced). For the purpose of this consultation, we have assumed that no direct construction impact, either temporary or permanent will occur within SWH due to levee reshaping. If this assumption is later determined to not apply and impacts to SWH become known, the Corps will need to reinitiate consultation.

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in a combined permanent loss of 1 acre of SWH and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance. Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of 233 acres of SWH in waters isolated by the structures (66 acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[4]).

Based on updated information provided by the Corps since the BA was issued, gate closure operations are expected to increase over the 50 year project life due to sea level rise. Just after project completion, around 2025, the closure structures would be operated rarely, generally during the wettest of year types such as 1983 and 1997. Under such extremely wet conditions, the gates may close for a full tidal cycle each day for several weeks during the January-March period. Under other water year types, the gates would be rarely operated. However, after several decades and certainly by the end of the project life, sea level rise will require much more frequent gate closure operations and for longer periods during the January-March period when delta smelt may be present. The frequency of gate closure of 6 hours or more would still be greatest in wet years but could occur every day for a full tidal cycle for several months. Additionally, sea level rise will require moderately frequent short term gate closure on the order of 2-4 hours per day for several days to weeks in all months, including summer months, in all year types. Even with sea level rise, the gates would not be continuously closed for a full day or more except during major events during the wettest water years (1-2 times per century).

As sea level rises, the timing of this operation will overlap an increasing proportion of the delta smelt spawning season. Adult smelt seeking areas to spawn could be prevented from entering the area isolated by the closure structure, or could be trapped behind the closure structure. Trapped adults may spawn behind the structure and the eggs or newly-hatched larvae would likely be adversely affected by isolation from tidal flows. Because of the current rarity of smelt and variability in spawning timing, it is not possible to predict the magnitude of such impacts nor avoid them. However, smelt upstream movements may be cued by the same tide and precipitation events that require gate closure. If this is the case, the effect on smelt could be greater than that predicted from the relative proportion of time that the gates are closed.

Long term monitoring of the delta smelt indicates that its distribution within the Delta varies between years and, while it has not been seen in the project area recently, the species was

[4] Service rough estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion it is assumed that all surface water in these eastern channel areas falls within the SWH limits discussed in this section.

detected in prior years when the population was somewhat more abundant. For example, adult smelt were noted in Spring Kodiak trawls in 2003 and 2004 slightly to the north and west of the project area. A small numbers of larval smelt were captured in April 1999 on the San Joaquin River near the confluence with the Calaveras River, within the project area. Records of beach seining at Dad's Point, which is at the mouth of Smith Canal where one of the closure structures is proposed, include captures of small numbers of adult smelt from 1979 to 2000. Taken as a whole, we believe it is likely that delta smelt do occur in the project area and would be affected by gate closure operations on Smith Canal and Fourteenmile Slough. To assess this conclusion, we have developed a Term and Condition for limited pre- and post-project sampling for smelt and other representative information in the sloughs affected by the closure structures. However, the ability to detect smelt from such sampling is limited by the extremely low populations. Additionally, sampling results cannot be used to manage gate operations because gate closure operations is strictly based on water stage to avoid the risks of levee damage and failure.

The effect of this expected gate closure on the species is difficult to estimate, but is potentially significant. Tidal flows have a wide range of benefits, including the transport of nutrients, organic matter, animals, and food organisms, and the establishment and maintenance of a salinity gradient. The tidal prism (i.e., the volume of water exchanged between low and high tide) would be incrementally reduced by gate operations. The timing of the longer gate closures, in January-March, overlaps the period of smelt potential occurrence and spawning in the project area and has the obvious potential to impact the species. The more frequent short term gate closures, which would eventually occur in all months, may have adverse impacts on fish behavior and interactions. For example, many smaller fish species school and predators feed during and around slack tides, including the highest tides which would be affected by gate closure. The manner in which gate closure operations affect these interactions cannot be easily estimated or measured.

Throughout the project, the proposed removal of vegetation and maintenance of portions of levees free of vegetation along channels will reduce these inputs and incrementally affect the quality and productivity of connected tidal waterways. Inputs of wood, leaves, terrestrial insects, and organic matter generally are a function of the presence of riparian vegetation. These inputs can provide a resource base supporting food organisms and a spawning substrate used by a variety of fishes including delta smelt.

Benefits to delta smelt will accrue from the purchase of 123 credits from a Service-approved conservation bank. The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. For this reason, we believe that the 123 credits proposed are appropriate compensation for the effects on the 233 acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

Delta Smelt Critical Habitat

This opinion on the critical habitat for the delta smelt does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statute and the August 6, 2004, Ninth Circuit Court of Appeals decision in *Gifford Pinchot Task Force v. U. S. Fish and Wildlife Service* (No. 03-35279) to complete the following analysis with respect to critical habitat.

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about 1 acre and temporarily affect 3 acres. These effects will be offset through the purchase of 3 credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on 233 acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of 120 credits at a delta smelt conservation bank.

Giant Garter Snake

Much of the proposed project construction occurs in uplands within 30 feet to aquatic habitat that could be considered potentially occupied by the snake during the active season. Although the quality of this potential snake habitat varies, the extent of this habitat is beyond the reaches identified in the BA. BA Plate 2 identified as snake habitat only the project work reaches along Fourteenmile Slough and portions of the north and south banks of the Calaveras River east of I-5. Based on our review of the BA and site visits to the project area, the Service considers portions of Mosher Slough, Shima Tract, and Tenmile Slough, and all of French Camp Slough and Duck Creek to be potential snake habitat as well.

Several of the construction methods proposed (cutoff wall, levee reshaping, seismic fix, levee raise, new levee) will involve upland disturbance that will at least temporarily affect snake upland habitat. Where levees are modified, clearing and degrading the top half of the levee to provide a platform of at least 30 ft wide is needed. Much of the work is designed so that most, but not all, of the disturbance is on the land side of the levee. Nevertheless, most of the upland work is within 200 ft of aquatic habitat that is considered snake habitat. Snakes will not be able to use this area for refugia, and any burrowing snakes present before construction begins could be killed. Snakes might enter the site and be crushed by heavy equipment. These effects will be minimized by the proposed inspection before construction, and monitoring during work, and exclusionary fencing where possible and appropriate. Most of this upland habitat will be restored within one season or less after construction. However, there will be some permanent impact in the form of new erosion protection on the Delta front work (Shima Tract, Fourteenmile Slough, Tenmile Slough). The effect of this new erosion protection on the snake is likely to be limited because of the relatively low quality of the ditches that constitute the nearest aquatic habitat to these locations. Some better upland snake habitat is on the east side of these levees, and those levee faces will remain unarmored. Overall, we estimate there to be about 111.5 acres of temporary impact on upland snake habitat.

Some of the work will affect snake aquatic habitat. Permanent losses will be limited to the footprint area of the Fourteenmile Slough closure structure and are estimated at 1 acre or less. Temporary disturbances of aquatic habitat includes removal and relocation of land (west) side ditches bordering Shima Tract and Fivemile, Tenmile and Fourteenmile Sloughs. We estimate the area of such aquatic temporary disturbance to be not more than 3 acres (assuming a 5-ft bottom width of ditch) and up to 3 acres of temporary disturbance of Fourteenmile Slough for the construction of the closure structure.

There will also be some permanent effects on snake upland habitat. These include landside (i.e., west) levee slope armoring of the delta front levee improvements in certain reaches of Shima Tract (ST_20_R) and Fourteenmile Slough (FM_30_L, FM_40_L, FM_60_L), and top of levee road construction for Duck Creek (all reaches). The total estimated impact for this work is 12.52 acres (permanent conversions of upland within 200 feet of snake aquatic impact; see consultation history, Corps email dated March 10, 2016). The Corps has committed to offset these impacts by purchase of credits at a 1:1 ratio. Based on the Service's initial evaluation of site conditions, this is to be considered a maximum and subject to confirmation or adjustment downward with further study of habitat suitability.

The ETL compliance work may directly kill snakes during removal of non-compliant vegetation and encroachments. This can be minimized by monitoring and inspection, and by disposing and inspecting waste vegetation in a manner which best detects any snakes present in the material. When this compliance work is complete, the thickness of woody vegetation will be substantially reduced from current conditions in a number of project reaches (Mosher Slough, Shima Tract, Calaveras River, French Camp Slough). This may allow some additional herbaceous upland and near shore aquatic vegetation to establish where it was otherwise shaded out by woody vegetation, and could modestly benefit the snake.

Operations and maintenance activities following construction will also affect the snake. Activities such as grouting, mowing, and maintenance to ETL standards (including a variance, if approved), will result in adverse effects on the snake and will continue for the life of the project. Grouting could entomb any snakes in animal burrows, and reduce the availability of refugia. The effect of the project on refugia availability is believed to be limited due to the presence of alternative forms of refugia, including riprap of a size sufficient to provide open voids, fallen wood and brush, and animal burrows which are formed and used by the snake between inspection/maintenance cycles. Monitoring information on the extent and frequency of grouting, and on alternative refugia will be useful to assess the expected continued availability, albeit reduced, of such refugia (i.e., reformed animal burrows or alternative forms) with the LSJRFS and its operation. Mowing could also kill snakes, or expose them to predators such as hawks and raccoons. Channel maintenance to maintain channel capacity may remove sediment bars and associated emergent vegetation and brush that is habitat to the snake.

Based on our evaluation, we consider the proposed 22.62 credits for the effect of grouting on snakes is also to be a maximum, subject to confirmation or adjustment downward with further evaluation of site conditions on some of the reaches. Specifically, a portion of Calaveras Reach CR_20_L is beyond the 200 foot criterion for snake upland habitat. A portion of Calaveras Reach CR_30_R appears to be currently armored, and if so would not function as upland habitat. Finally, a significant portion of the Calaveras River reaches to the east (CR_60_R, CR_70_R, CR_80_R, CR_40_L, CR_50_L, CR_60_L, CR_70_L) are within 200 feet, but substantially more than 30 feet, from the aquatic habitat. While the levee slope uplands in these reaches would be subject to grouting, they would rarely be used by snakes during the active season because of the distance from water. Rather, these reaches have uplands within the flood channel well outside of the levee profile that would not be subject to grouting activity and are adjacent to water that are more likely to be used for summer refugia. Any future adjustment to either the 12.5 credit offset for permanent snake upland effects or 22.26 credit offset for upland grouting effects on the snake, is not part of this biological opinion, and will require reinitiation of consultation with the Service.

The conservation measures will limit effects on the snake. Monitoring will be done to limit direct effects on snakes during construction. Bank credits will be purchased to offset permanent losses of snake habitat and unavoidable effects of grouting near potential snake habitat. This will help maintain the geographic distribution of the species and contribute to recovery by augmenting the extent of habitat secure from threats. Seasonal restrictions, training, and other measures will further reduce effects on the snake. The Corps will consult separately on any effects of channel maintenance.

Valley Elderberry Longhorn Beetle

Habitat for the beetle will be adversely affected by direct removal of elderberry bushes during construction and maintenance of the project. Up to 44 bushes with 151 stems are within or near enough (i.e., closer than 100 ft) to the footprint or maintenance easements that they could be affected by the project. However, this is a maximum amount and it is anticipated that the 18 bushes that are closer than 100 ft from the footprint or maintenance easements will be avoided through compensation measures. To ensure that these 18 shrubs are not affected by construction, the Corps will monitor their condition and viability for two years after construction. If mortality or reduction in condition of these shrubs is observed, additional mitigation will be performed. There are 26 shrubs within the footprint of the project that will require removal, either for construction or to bring existing or new maintenance easements into compliance with the ETL. Some of these will be lost while others could be transplanted. Some mortality or reduction in health of the transplanted shrubs may occur. There is adequate area within the setback compensation area to accommodate the maximum 297 elderberry plantings and associated native plantings needed to be in accordance with the Conservation Guidelines if all 44 bushes and 151 stems within the footprint and within 100 ft of the footprint were found to be impacted. The Corps has also proposed to conduct additional study to evaluate the compensation site to ensure that it will support elderberries.

Elderberry plants, as well as other native and non-native vegetation, will be removed to establish ETL compliance and regularly maintain the project per the Corps' OMRRR manual thereafter. This could result in locally restricting the distribution of the beetle if maintenance precluded elderberry shrub from these waterways. Such effects will be reduced if elderberries re-establish within portions of the project where vegetation is allowed by variance. Such re-establishment is uncertain because elderberry plants usually grow on higher terraces, and the area to be considered for a variance is the lower half of the waterside slope. If elderberry plants did grow back in variance areas, they will likely still be affected by trimming or the need for removal. These effects of maintenance will be subject to measures to avoid impacts, and where it must occur it will be limited in extent and/or offset by additional plantings. The overall effect of the conservation measures will be to sustain beetle habitat to the extent allowable and consistent with project operation and maintenance, while compensating for unavoidable losses near the project area. This is consistent with the need to augment and enhance habitat in or near managed waterways that could otherwise be subject to complete loss of beetle habitat.

Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the action area considered in this biological opinion. Future Federal actions that are unrelated to the proposed LSJRFS are not considered in this section; they require separate consultation pursuant to Section 7 of the Act. The Service is not aware of specific projects that might affect the smelt, snake, or beetle in the action area that are currently under review by State, county, or federal authorities.

Conclusion

After reviewing the current status of delta smelt, giant garter snake, and valley elderberry longhorn beetle, the environmental baseline for the action area, the effects of the proposed action, and the cumulative effects on these species, it is the Service's biological opinion that the proposed LSJRFS is not likely to jeopardize the continued existence of these species. The Service reached this conclusion because the project-related effects when added to the environmental baseline and considering cumulative effects, will not rise to levels that preclude recovery or reduce the likelihood of survival of the species. This is based on implementation of the conservation measures proposed by the Corps including: measures to avoid, limit, and monitor effects of construction and operation and maintenance; measures to restore temporarily affected habitat; and measures to provide compensation habitat for the smelt and snake to offset permanent impacts and effects of maintenance grouting through purchase of credits; and development of a setback compensation area which will provide habitat for the beetle.

Based on review of these same factors, it is the Service's biological opinion that the proposed LSJRFS is not likely to destroy or adversely modify designated critical habitat for delta smelt. This is because the effects on the critical habitat are discrete and relatively small in area compared to the total area designated and will be minimized through compensatory mitigation, and as such are not expected to appreciably reduce the value of the critical habitat or prevent it from sustaining the species.

INCIDENTAL TAKE STATEMENT

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harass is defined by the Service as an intentional or negligent act or omission which creates the likelihood of injury to a listed species by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding or sheltering. Harm is defined by the Service to include significant habitat modification or degradation that results in death or injury to listed species by significantly impairing essential behavioral patterns including breeding, feeding, or sheltering. Incidental take is defined as take that is incidental to, and not the purpose of, the carrying out of an otherwise lawful activity. Under the terms of section 7(b)(4) and section 7(o)(2), taking incidental to and not intended as part of the agency action is not considered to be prohibited taking under the Act, provided that such taking is in compliance with the terms and conditions of this Incidental Take Statement.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this incidental take statement. If the Corps (1) fails to assume and implement the terms and conditions or (2) fails to require SJAFCA to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the OMRRR or any permit or grant document related to the LSJRFS, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(3)].

Amount or Extent of Take

Delta Smelt

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in 4 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (1 acre of fill in the footprints of the closure structures; 3 acres of temporary loss in the construction area of the closure structures).

As for the effect of tidal gate operations on the 233 acres of SWH east of the closure structures that would be seasonally and diurnally affected by gate operation, incidental take of delta smelt will be difficult to evaluate directly. Because of the extremely low population of the species, sampling is unlikely to detect smelt even if they were present. Any such detections will mean that take is occurring and our analysis requires re-evaluation. Initially, the Corps will develop and conduct a fixed term of focused pre- and post-project sampling within the affected sloughs required as a term and condition of this biological opinion. We acknowledge that the effects are partial, and would be offset by purchase of credits. We anticipate incidental take of two (2) adult or juvenile delta smelt for the area affected by the closure structures. Detection of two adult or juvenile delta smelt in Smith Canal or Fourteenmile Slough during the focused sampling by the Corps, or within these waters by other independent sampling after the project has been completed, will mean that the smelt is being or could be affected by the project in excess of the expected effects in these locations.

Giant Garter Snake

The Service anticipates that incidental take of the snake will be difficult to detect or quantify for the following reasons: snakes are cryptically colored, secretive, and known to be sensitive to human activities. Snakes may avoid detection by retreating to burrows, soil crevices, vegetation, and other cover. Individual snakes are difficult to detect unless they are observed undisturbed at a distance. Most close-range observations represent chance encounters that are difficult to predict. It is not possible to make an accurate estimate of the number of snakes that will be harassed during construction activities, including in staging areas and roads carrying vehicular traffic. In instances when take is difficult to detect, the Service may estimate take in numbers of species per acre of habitat lost or degraded as a result of the action as a surrogate measure for quantifying individuals. The Service anticipates no more than 2 giant garter snakes total in the 128 acres of aquatic and upland habitat affected during construction and maintenance (101.5 upland temporary, 12.5 upland permanent, 0.5 aquatic temporary, and 0.5 acre aquatic permanent habitats) will be harmed or killed due to the proposed project and its maintenance over the 50-year project life. The cumulative detection of two (2) snakes over the combined periods of construction and maintenance is to be used to determine when take is exceeded. Detection of 2 snakes will indicate that the snake is being affected by the project at a level where avoidance and minimization measures and project implementation need to be re-evaluated and possibly modified.

Valley Elderberry Longhorn Beetle

The Service anticipates that incidental take of valley elderberry longhorn beetle will be difficult to detect due to its life history and ecology. Specifically, valley elderberry longhorn beetles can be difficult to locate due to the fact that a majority of their life cycle is spent in the elderberry shrub and finding a dead or injured individual is unlikely due to their relatively small size. There is a risk of harm, harassment, injury and mortality as a result of the proposed construction activities; therefore, the Service is authorizing take incidental to the proposed action as harm, harassment, injury, and mortality of all valley elderberry longhorn beetles within a maximum of 21 shrubs which will be removed due to project construction and vegetation removal for ETL compliance. Subject to the proposed compensation measure limitations on trimming, the Service authorizes incidental take of all beetles in bushes which are trimmed for maintenance purposes over the project's 50 year life. Subject to the proposed compensation measure limitations on removal, the Service also authorizes incidental take of all beetles in bushes that will be completely removed due to maintenance, up to a maximum of 75 bushes over the project's 50 year life. The cumulative detection of two adult beetles (i.e., live or dead specimens, not exit holes) over the combined periods of construction and maintenance is to be used to determine when take is exceeded. Detection of two beetles will indicate that the beetle is being affected by the project at a level where avoidance and minimization measures and project implementation need to be re-evaluated and possibly modified.

Effect of the Take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the delta smelt, giant garter snake, or valley elderberry longhorn beetle.

Reasonable and Prudent Measures

The necessary measures needed to avoid and minimize impacts on listed species due to the project have been incorporated into the project description. Therefore, the Service has determined that the following reasonable and prudent measure is necessary and appropriate to minimize incidental take of the smelt, snake, and beetle:

1. All conservation measures as stated in the Project Description section of this biological opinion shall be fully implemented and adhered to. This reasonable and prudent measure shall be supplemented by the terms and conditions below.

Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, the Corps must comply with, or ensure compliance with, the following terms and conditions, which implement the reasonable and prudent measure described above and outline required reporting/monitoring requirements. These Terms and Conditions are nondiscretionary.

The following Terms and Conditions implement the Reasonable and Prudent Measure:

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: (a) a pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically (i) areas of upland and aquatic habitat for the snake, (ii) numbers of elderberry shrubs and stems in the diameter classes considered habitat for the beetle in accordance with the Conservation Guidelines, and (iii) areas of Shallow Water Habitat as habitat for the smelt affected by the project including the footprint of proposed gate structures, the operational periods of such gates, and the area(s) isolated by such gates; (b) a cumulative accounting of the effects on listed species habitat of all phases constructed to date; (c) a narrative describing how the already constructed plus additional proposed work effects fall within the take limits described in this biological opinion; (d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction; (e) its approved ETL variance for that phase, with a narrative explaining how it is consistent with the project description of this biological opinion, and a determination that the effects are within the parameters of allowable take; (f) detailed survey protocols for implementing those measures shown in Appendix A of this biological opinion; and (g) a request to the Service for written concurrence with items 1(c) ,1(e), and 1(f). If the Service concurs, we shall issue a letter of concurrence and the Corps may proceed with construction and OMRRR under this biological opinion. If we do not concur, we will specify our reasons and the Corps must re-initiate formal consultation.

   In order to accurately estimate take, the Corps shall resurvey areas with pending construction for elderberry shrubs no sooner than one year prior to the onset of that construction.

2. The Corps will conduct adequate preliminary study of the proposed beetle compensation area to assess suitability to support elderberry plants and beetle. This study shall include but is not limited to; evaluation of soil texture, chemistry, and composition; soil water and chemistry; potential effects of adjacent uses and factors that may adversely affect elderberry (pesticides, herbicides); management needs; and a proposed monitoring plan. The Corps will prepare a report of this study and submit it to the Service with a request for written finding from us concurring that the site is suitable for compensation for effects of the project on beetle. If the Service concurs, the Corps may proceed with development of that compensation site. If we do not concur, the Corps will need to develop alternative means of compensation before project construction, and reinitiation will be required.

3. The Corps will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work.

4. The Corps will prepare and submit to the Service for approval, a sampling plan designed to detect any delta smelt that may be using Smith Canal or Fourteenmile Slough. The general parameters of this sampling are that it should be limited to three seasons, of which at least two seasons will be before project construction, and the post-construction sampling is to be conducted no later than three years after construction. This plan must be approved by the Service in writing prior to the onset of monitoring.

5. The Corps will prepare and submit to the Service for approval, a monitoring plan designed to quantify the extent and distribution of alternative snake refugia. The general parameters of this monitoring are that it will be done pre-project and then at five year intervals thereafter until the project is completed, encompass all snake habitat as identified in this biological opinion during each monitoring year (both constructed and to-be-constructed reaches), and differentiate the forms of alternative refugia. Due to construction duration, the last monitoring year may be several years after all project work is complete. This plan must be approved by the Service in writing prior to the onset of monitoring.

6. The Corps will prepare and submit to the Service for approval, a monitoring plan which details the protocols for implementing construction snake monitoring as described in this biological opinion (Conservation Measures; Appendix B). This plan must be approved by the Service at least 90 days in advance of construction.

7. The Corps will conduct five years of monitoring of beetle compensation areas.

The Service believes that no more than the quantities specified in the Incidental Take Statement will be incidentally taken as a result of the proposed action. The reasonable and prudent measures, with their implementing terms and conditions, are designed to minimize the impact of incidental take that might otherwise result from the proposed action. If, during the course of the action, this level of incidental take is exceeded, such incidental take represents new information requiring reinitiation of consultation and review of the reasonable and prudent measures provided. The Corps must immediately provide an explanation of the causes of the taking and review with the Service the need for possible modification of the reasonable and prudent measures.

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to the following monitoring requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-5604, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps (during construction) or the local sponsor (during maintenance) shall follow the steps outlined in the Disposition of Individuals Taken section below. The Corps shall incorporate this notification information as a requirement in the OMRRR.

2. The Corps will document, monitor, and report the actual amount of take of listed species and listed species habitat for project construction of each discrete phase or contract of the project, and submit a post-construction monitoring report within 180 days of completion. This document will include: (a) photo-documentation immediately before construction, and after completion of construction; (b) a comparison of the as-built effects on listed species habitat with that described in Term and Condition No. 1; and (c) a summary table of construction monitoring to verify that the monitoring extent and frequency are consistent with that proposed, the sightings of any listed species, and any observed effect on habitat beyond that described in the design.

3. The Corps will develop a requirement in its OMRRR manual for the local sponsor to maintain a record of operations and maintenance activities as they affect listed species and reporting of such in an annual report to the Service. The report will cover calendar year activities, and be submitted to the Service by March 1 of the year following. This requirement will include a record of the dates, types, locations, areas, and frequencies of maintenance activities, extent of compliance with conservation measures in this biological opinion associated with maintenance, and the take of any listed species or lack thereof. Example parameters may include areas mowed within 30 ft of snake habitat, a tally of the number of rodent holes grouted within 30 ft of snake habitat in particular areas, the number of elderberry shrubs present, avoided, trimmed, or removed, and so on. The Corps will provide a draft of this requirement to the Service for review and concurrence that it adequately documents the effect of maintenance on listed species. If the Service concurs, the Corps may proceed with finalizing its OMRRR manual. If we do not concur, we will specify our reasons and alternative language that fulfills this need.

4. Additional Reporting: Within 90 days of completion of the last data collection of the year for each monitoring requirement, the Corps will submit (a) baseline and annual reports of the health and condition of elderberry shrubs not directly affected, but within 100 ft of project work (one baseline and two post-construction reports per construction phase); and any associated additional mitigation; (b) preconstruction and, at 5-year intervals until construction is complete, reports documenting quantities of alternative snake refugia; and (c) pre- and post-construction reports of delta smelt sampling in Fourteenmile Slough and Smith Canal.

Disposition of Individuals Taken

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as the Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen must be frozen in a freezer located in a secure site, until instruction s are received from the Service regarding the disposition of the dead specimen. The Service contact persons are the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-5604; and the Resident Agent-in-Charge of the Service's Office of Law Enforcement, 5622 Price Way, McClellan, California 95562, at (916) 569-8444.

CONSERVATION RECOMMENDATIONS

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The Service recommends the Corps develop and implement restoration measures in areas designated in the Delta Fishes Recovery Plan (Service 1996) the Giant Garter Snake Recovery Plan (Service 2015) and the Valley Elderberry Longhorn Beetle Recovery Plan (Service1984).

2. The Corps and SAFCA should develop and implement projects that support DWR's Central Valley Flood System Conservation Strategy. This document provides goals and measurable objectives and potential projects which could be implemented in a manner that while improving the riverine ecosystem also will improve the flood system.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

REINITIATION—CLOSING STATEMENT

This concludes formal consultation on the Lower San Joaquin River Feasibility Study. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary

Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this biological opinion on the proposed Lower San Joaquin River Feasibility Study, please contact Steven Schoenberg of my staff at (916) 414-6564.

Sincerely,

Kaylee Allen

Kaylee Allen
Field Supervisor

cc:

Tanis Toland, Corps of Engineers, Sacramento, CA
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Appendix A. Lower San Joaquin River Feasibility Study: reach-specific construction measures, Service assessment of giant garter snake habitat suitability,and Corps/Service agreed to avoidance/minimization measures.

Reach[1]	Waterway	Reach Boundaries	Construction Measure(s)[2]	Suitability as snake Habitat	Proposed avoidance/minimization measures and effect determination
MC_30L (6,600 ft)	Mosher Slough	Thornton Road to railroad tracks	Cutoff wall	Wetted channel after storms but no emergent vegetation; believed to be dry in this reach in summer; only urban adjacent; non-tidal; minimal forage/lack of water means presence unlikely.***	Training of workstaff as to identification and what to do if there is an incidental suspected observation of snakes. Not considered snake habitat.
MC_10L, MC_20L, 10,700 ft	Mosher Slough	Shima Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)	Begins to show evidence of permanent water near little Bear Creek. Heavy shade and small patches of emergents but mostly open surface. Snake forage probably improved. Likelihood of snake presence low but possible.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Reduction of woody plants from project actions may enhance basking for snake. Maintenance effects of grouting, mowing, etc., apply.
ST_10R, ST_20R, (6,700 ft)	Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)[3]	ST_20R only: Substantial emergent vegetation; summer open water; possible snake forage from amphibians and/or introduced vector control (mosquito fish). Small patch size; interrupted hydrologic continuity to other snake habitat. ST_10R: No adjacent snake habitat.	ST_20R only: Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Reduction of woody plants here may enhance basking for snake. Maintenance effects of grouting, mowing, etc. ST_10R only: Insignificant effects on snakes due to lack of habitat (no inspections required).
FS_10R (1,700 ft)	Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)[3]	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Minimal maintenance effects due to heavily rocked waterside slope requires no grouting, infrequent maintenance.
FM_60_L (1,600 ft)	Fourteenmile Slough	Fivemile Slough to Proposed Closure Structure	Seismic Fix; Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)[3]	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. Minimal maintenance effects due to heavily rocked waterside slope requires no grouting, infrequent maintenance.
FM_50_L, (300 ft)	Fourteenmile Slough	Approximately 1,500 ft west of Fivemile Slough	Closure Structure	Some floating vegetation, very small emergent patches; hydrologically connected to other potential snake habitat.	Training, pre-work inspection, and daily morning inspection of work site travel routes within 200 ft of work only to declare them snake free. No/minimal maintenance effect or operational effects on snakes. Small direct loss of upland/aquatic in footprint.**
FM_40_L, (1,500 ft)	Fourteenmile Slough	Approximately 1,250 ft southeast setback out from proposed closure structure	Seismic Fix Levee height fix (sea level rise) Erosion protection (landside)[3]	Within 200 ft of potential habitat, but does not constitute snake habitat. No permanent/seasonal wetland vegetation; no ditches seen.***	Training, pre-work inspection, and daily morning inspection of work site travel routes within 200 ft of work to declare them snake free. No other effects anticipated.
FM_30_L (7,000 ft),	Fourteenmile Slough	From setback cut south to Tenmile Slough	Seismic Fix (adjacent levee) Erosion protection (landside)[3] Setback levee	West: low-value potential snake habitat in form of small ditch with temporary intermittent water if any. East: much higher value potential snake habitat in portions of 14-mile slough within 200 ft of work.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap removes burrow potential but effect deemed discountable (no offset). Dewater ditch and reinspect before grading/removal. Low value ditch habitat to be lost, but might be expected to be replaced by a new ditch to west of setback levee
TS_30_L (5,900 ft)	Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope Reshaping Erosion protection (waterside)[3]	West: low value potential snake habitat in ditch with some emergent vegetation. East: developed. Levee slopes compacted with granular armor.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap removes burrow potential but effect deemed discountable. If ditch habitat is to be affected, dewater ditch and reinspect before grading/removal. Ditch may be replaced if affected, as it appears to be part of agricultural operations.

TS_20_L (1,600 ft),	Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic Fix; Slope Reshaping Erosion protection (waterside)	Some floating vegetation, patches of emergent vegetation, and close proximity to other habitat in Bulkley Cove, but low value snake habitat due to major river location.	Training, pre-work inspection, and daily morning inspection of work site to declare it snake free. New west-side riprap replaces compacted granular rock surface with no burrowing seen due to maintenance.
TS_10_L (4,000 ft)	Tenmile Slough/Buckley Cove	West March Lane/Buckley Cove Way to Calaveras River	Seismic Fix; Slope Reshaping	Larger patches of emergents on-site, slightly off major river, proximity to other (upstream) habitat), but low value snake habitat due to predominant shoreline development.	Training, pre-work inspection, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during maintenance. *
CR_10_R (2,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Fairway Dr.	Cutoff wall	Similar condition to TS_10_L, but slightly better in terms of proximity to natural island habitat.	Training, pre-work inspection, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during/for maintenance.*
CR_20_R (1,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Fairway Ave.	Cutoff wall	Similar to CR_10_R, but less intense shoreline development (on south bank), and closer proximity to islands.	Training, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance precludes any burrows which occur. Monitor plus measures during/for maintenance.*
CR_30_R (3,800 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite Kirk St.	Cutoff wall	Better quality habitat than CR_20_R, due to adjacent side channel, shallow water emergent wetland	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_40_R (2,300 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit ~opposite I-5.	Cutoff wall	Better quality snake habitat nearby, but not immediately adjacent to this reach, includes side channel and shallow water emergent wetland.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_50_R (6,900 ft)	Calaveras River – Right/North Bank	Calaveras River, upstream limit N. Pershing Ave.	Cutoff wall	Increasing quality snake habitat includes adjacent shallow water side channels with floating and/or emergent wetland, herbaceous cover on banks and (near N. Pershing) grasslands within channel, islands, and open water.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_60_R, (1,400 ft) CR_70_R, (1,800 ft)	Calaveras River – Right/North Bank	Calaveras River, N. Pershing to Pacific Aves.	Cutoff wall	Increased snake habitat quality and potential for occurrence with shallow water side and main channels with maintained grassy levee slopes and bench areas between levees. Some Arundo.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_80_R (3,200 ft)	Calaveras River – Right/North Bank	Calaveras River, Pacific Ave. to El Dorado Street	Cutoff wall	Increased snake habitat quality and potential for occurrence with shallow water, primarily in main channel, with maintained grassy levee slopes and bench areas between levees. Limited marginal vegetation; channel may be maintained/cleared.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*

CR_10_L, (1,700 ft)	Calaveras River – Left/South Bank	From about Fairway Dr to Rainer Ave	Cutoff wall	Better quality potential snake habitat than at river mouth due to proximity to islands, much less riprap on south bank, and less dock development.	Training, daily morning inspection and one mid-day inspection of work site (work stoppage not required) to declare it snake free. No new riprap proposed but waterside maintenance to preclude any burrows which occur (increase over existing maintenance based on observed condition). Monitor plus measures during/for maintenance.*
CR_20_L, (4,300 ft)	Calaveras River – Left/South Bank	From about Rainer Ave to Kirk Street	Cutoff wall	Varies; better quality upland than elsewhere, owing to larger habitat width, thus less urban disturbance; portions >400 ft from water, therefore not encroached into proposed levee profile, but this varies. Water edge steep, across from wetland on north bank.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_30_L (1,600 ft)	Calaveras River – Left/South Bank	From about Kirk Street to I5	Cutoff wall	Riparian/upland with gaps. The adjacent river is a uniform single thread in this reach, lacking islands, backwaters, or side channels that are present upstream and downstream. A few docks are present.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_40_L (6,900 ft)	Calaveras River – Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping	Riparian, more or less continuous but of younger stands; some riprap; some steeper slopes and some open gaps; mid-channel islands; floating vegetation prominent in upper end.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_50_L, (1,700)	Calaveras River – Left/South Bank	Approximately North Pershing Avenue to unnamed narrow bridge by University of the Pacific campus.	Cutoff wall	Riparian, sparse trees with gaps, grassland between levees, and island vegetation. Shallow water, arundo islands; no rock toe observed. Increasing snake habitat quality.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_60_L (1,600 ft)	Calaveras River – Left/South Bank	Approximately unnamed narrow bridge by University of the Pacific campus to North Pacific Avenue.	Cutoff wall	Similar to CR_50_L, and with more herbaceous upland between levees than elsewhere; variable channel (open, narrow, and/or scrub islands)	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
CR_70_L (3,200 ft)	Calaveras River – Left/South Bank	Approximately North Pacific Avenue to El Dorado Street	Cutoff wall	Continuation of CR_60_L; similar conditions.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
SC_30 (800 ft)	Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure Structure	Deep water work , near SJR, minimal edge cover nearby; snake presence unlikely***	Worker training only.
SJR_10_ R, (8,600 ft)	San Joaquin River	From approximately 2,100 ft upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)	Work adjacent to SJR; riparian and golf course with ponds nearby; snake presence unlikely. Not examined on ground.***	Worker training only.
SJR_20_ R (600 ft)	Smith Canal	Dad's Point from the Closure Structure to approximately 375 ft down Monte Diablo Avenue	Floodwall	Work adjacent to open deep waters of SJR and Smith Canal; lower stature riparian in managed park setting; snake presence discountable.***	Worker training only.
SJR_30_ R (3,500 ft)	San Joaquin River	Railroad bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping	Work adjacent to open deep waters of SJR and disturbed sewage treatment location. snake presence discountable.***	Worker training only.
SJR_40_ R, (4,400 ft) SJR_50_ R, (2,000 ft) SJR_60_ R, (2,100 ft)	San Joaquin River	Burns Cutoff to SR-4	Cutoff wall	As with SJR-30_R.***	Worker training only.

SJR_70_ R (4,100 ft)	San Joaquin River	SR 4 to French Camp Slough	Cutoff wall	Work adjacent to open deep waters of SJR and golf course; some marsh fragments and floating vegetation near French Camp Slough confluence. Slight potential for snakes.	Training and, for work within the first 400 ft of north bank nearest to French Camp Slough, daily morning inspection of work site to declare it snake free.
FCS_10_ R (9,000 ft)	French Camp Slough	Part of CS-E-9 "a" and "b" NEPA Reaches	Cutoff wall	Increased habitat quality for snakes and potential for presence due to location off of main river, presence of larger marsh blocks, shallower waters. Some toe rock. Some riparian habitat on lower slope.	Training, pre-work inspection, and continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Monitor plus measures during/for maintenance.*
DC_10_R (450 ft)	Duck Creek ("a" only)	French Camp Slough to 500 ft past I-5 crossing	Cutoff wall	Increased snake habitat quality and presence potential; shallow water, high coverage of floating plants and emergents; some open water visible on aerial photos; semi-rural to suburban adjacent land use.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*
DC_20_R (2,450 ft)	Duck Creek	500 ft past I-5 crossing to approximately Odell Avenue	New Levee	Increased snake habitat quality and presence potential; shallow water, high coverage of floating plants and emergent vegetation; some open water visible on aerial photos; semi-rural to suburban adjacent land use.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects much more significant due to higher quality of habitat and construction of new levee. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*
DC_30_R (2,450 ft)	Duck Creek	Approximately Odell Avenue to McKinley Avenue	Fix in-place Cutoff wall Levee Reshaping Levee height fix	Not observed; aerial images suggest similar to adjacent downstream sections. Assume similar habitat quality.	Training, pre-work inspection, and either fencing or continuous monitoring during work by on-site monitor. Tree encroachments to be removed and grouting effects more significant due to higher quality of habitat and reshaping work specified. Upland loss from expected paved road on levee.** Monitor plus measures during/for maintenance.*

* single asterisk denotes this site included in determination of maintenance offset compensation determination.
** double asterisks denote inclusion in direct loss offset compensation determination.
*** triple asterisks denote determination of "no effect" on snake with application of the proposed conservation measures (i.e., insignificant, discountable, and/or wholly beneficial).

[1] Equivalent to "cost reach" in Appendix C of the Corps' BA.

[2] The term "waterside" refers to the ecological waterside (i.e., towards any proximate canal, slough, river or stream channel) and "landside" opposite the waterside. Toe drains and agricultural ditches are not considered waterside.

[3] The new erosion protection included in the Recommended Plan will be placed either on the waterside of the levee or on the landside of the levee. All of this new erosion protection is placed above the waterline. The purpose of the North Stockton erosion protection is protect the project levee from wind and wave run-up erosion which could occur if Delta levees to the west of the project levee were to fail allowing flooding of land immediately west of the project levee. Erosion protection on Duck Creek is no longer proposed (see Consultation History).

Note: New levees = 20 ft OMRRR easement (each side); existing non-Federal levees newly brought into the Federal system = 10 to 15 ft OMRRR easements.

Appendix B: verbatim attachment to April 13, 2016 email from Service to Corps (reformatted for this biological opinion)

Table E: Pre-Project Vegetation and Vegetation Lost from Project Implementation. Original from Corps (Toland) dated December 10, 2015, as corrected by FWS (SCHOENBERG) per 4/13/16 teleconference w/ CORPS Colby/Garcia. Edits are shown in **enlarged boldface.** This table shows pre-project (i.e., existing) vegetation, vegetation lost due to construction of the structural flood risk management features, and vegetation lost due to implementation of vegetation free zones that removes 75% of the vegetation **from the waterside, and 100% of the vegetation from the landside,** that remain after construction of the structural flood risk management features.

A	B	C	D	E	F	G	H
MOSHER SLOUGH	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss After ETL (lower levee) E-F	Total Project Veg Loss D+G
Waterside Slope							
	Woody Riparian	3	1	2	0.5	1.5	2.5
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	0	0	0	0	0	0
	Woody Riparian	1	1	0	0	0	1
	Wetlands	3	3	0	0	0	3
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	3	3	0	0	0	3
Landside Slope							
	Woody Riparian	8	2	6	**0**	**6**	**8**
	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	7	4	3	**0**	**3**	**7**
	Grass (Park)	0	0	0	0	0	0
DELTA FRONT	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	2	1	1	0.25	0.75	1.75
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	0	0	0	0	0	0
	Woody Riparian	1	1	0	0	0	1

	Wetlands	4	4	0	0	0	4
	Grass	0.5	0	0.5	0.125	0.375	0.375
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	25	13	12	**0**	**12**	**25**
	Grass (Park)	2	2	0	0	0	2
Landside Easement							
	Woody Riparian	3	0	3	**0**	**3**	**3**
	Grass (Park)	1	1	0	0	0	1
Setback Levee							
As proposed mitigation	**TBD**	NA					
Calaveras River	Cover type	Overall	Construction	Veg on Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	7	4	3	0.75	2.25	6.25
	Wetlands	1	0	1	0.25	0.75	0.75
Waterside Easement							
	SRA (***LINEAR FEET***)	10406	0	10406	2601.5	7804.5	7804.5
	Woody Riparian	5	4	1	0.25	0.75	4.75
	Wetlands	1	1	0	0	0	1
	Grass	0.5	0.5	0	0	0	0.5
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	35	16	19	**0**	**19**	**35**
	Grass (Park)	3	3	0	0	0	3
Landside Easement							
	Woody Riparian	6	5	1	**0**	**1**	**6**
	Grass (Park)	2	2	0	0	0	2

San Joaquin DS of FCS	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	5	2	3	0.75	2.25	4.25
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	7949	1423	6526	1631.5	4894.5	6317.5
	Woody Riparian	5	4	1	0.25	0.75	4.75
	Wetlands	0	0	0	0	0	0
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	5	4	1	**0**	**1**	**5**
	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	3	1	2	**0**	**2**	**3**
	Grass (Park)	1	1	0	0	0	1
French Camp Slough & Duck Creek	Cover type	Pre-Project Total	Loss from Construction	Veg Remaining Lower Levee (below construction)	Veg Remaining after ETL 75% Removal for waterside; 100% for landside	Total Loss (lower levee)	Total Loss
Waterside Slope							
	Woody Riparian	2	1	1	0.25	0.75	1.75
	Wetlands	0	0	0	0	0	0
Waterside Easement							
	SRA (***LINEAR FEET***)	7153	576	6577	1644.25	4932.75	5508.75
	Woody Riparian	3	3	0	0	0	3
	Wetlands	0	0	0	0	0	0
	Grass	0	0	0	0	0	0
Levee Crown							
	Woody Riparian	0	0	0	0	0	0
Landside Slope							
	Woody Riparian	11	10	1	**0**	**1**	**11**

	Grass (Park)	0	0	0	0	0	0
Landside Easement							
	Woody Riparian	0	0	0	0	0	0
	Grass (Park)	0	0	0	0	0	0
New Levee							
	Woody Riparian	2	2	NA	NA	NA	2
	Wetlands	2	2	NA	NA	NA	2
	Row/Field Crops	1	1	NA	NA	NA	1

NOTE: All values in acres, except for SRA (in linear feet)

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer To:
08ESMF00-2015-F-0206-1

AUG 19 2019

Mr. Michael Jewell
Acting Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Reinitiation of formal consultation on the Lower San Joaquin River Feasibility Study, San Joaquin County, California; Smith Canal Gate SPK-2016-00037

Dear: Mr. Jewell:

This is in response to the U.S. Army Corps of Engineers' (Corps) October 19, 2018, letter requesting formal consultation with the U.S. Fish and Wildlife Service (Service) on issuance of an Army permit for the Smith Canal Gate Project (project). The project for which you are requesting consultation is an element of the Lower San Joaquin River Feasibility Study (LSJRFS) Recommended Plan, San Joaquin County, California, for which a Biological Opinion (BiOp) was previously issued on June 13, 2016. The LSJRFS is a Federal project with the Corps as the Federal lead agency and the Central Valley Flood Protection Board and the San Joaquin Area Flood Control Agency (SJAFCA) as the non-Federal local sponsors partnering with the Corps. The LSJRFS consists of improvements to 24 miles of levees in the Central and North Stockton areas to address seepage, slope stability, overtopping, and erosion concerns. Under the permit that is the subject of this consultation request, the Smith Canal Gate element would be constructed by SJAFCA as the applicant, instead of by the Corps with SJAFCA as the local sponsor.

At issue are effects of the project on the federally-listed as threatened delta smelt (*Hypomesus transpacificus*), and delta smelt critical habitat. Your request was received on October 22, 2018 with a Biological Assessment (BA). According to that BA, the project has been revised and the associated compensatory mitigation differs from that described in our 2016 BiOp. After receiving your request, we requested and received additional information, and participated in a meeting, site visit, and conferences with the Corps and applicant (see Consultation History). During the course of those activities, we concluded it appropriate to modify the compensatory mitigation for both the Smith Canal and Fourteenmile Slough gates. In order to maintain consistency, we have decided to treat your request as a reinitiation of formal consultation of the LSJRFS and to amend our 2016 BiOp as appropriate. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and is to be considered sufficient for the additional purpose of consultation on the issuance of an Army permit.

CONSULTATION HISTORY

June 13, 2016: Service issues its BiOp on the LSJRFS that includes gates on Fourteenmile Slough and Smith Canal among elements to improve flood risk management in the Stockton urban area. The project description for the LSJRFS in the BiOp specifies pre-construction purchase of 123 conservation bank credits for effects to smelt and its critical habitat of construction and to 233 acres of Shallow Water Habitat from operation of the two gates. The LSJRFS BiOp Terms and Conditions (T&C) requires a fisheries protection plan (T&C #3) and 3-year pre- and post-construction fish sampling plan (T&C #4) for smelt.

October 22, 2018: Service receives the Corps' October 19, 2018, request for formal consultation on issuance of Army permit for the Smith Canal Gate project and associated BA, which noted the project had been revised since issuance of the 2016 BiOp.

November 30, 2018: Services issues letter of information request to the Corps requesting evaluation of compensatory mitigation consistency or deviation from the LSJRFS BiOp, frequency and duration of gate operation with sea level rise, and changes in project description since LSJRFS BiOp.

February 12, 2019: Corps issues email response to information request, stating that compensatory mitigation for the project would occur at a ratio of 1:1 (credits:impact area) for permanent impact to 0.820 acre of "tidal perennial impact only," meaning the footprint of the gate and associated structures, referenced its BA for gate operations, and provided more detail on differences in project description. The Corps requested to confer with the Service.

April 26, 2019: Service meets with Corps and permit applicant's consultant (ICF); discussion topics included the potential benefits to smelt of proposed water hyacinth control (not proposed in the LSJRFS), or other analysis, to justify the difference (reduction) in compensatory mitigation from that in the LSJRFS BiOp. Service requested an updated analysis/justification, which the consultant estimated would be provided in 1-2 weeks.

May 16, 2019: Corps emails request for Service attendance at a site visit; includes forwarded attachment of October 2014 photos of water hyacinth extent in proposed project location from applicant's CEQA document.

May 17, 2019: Service emails Corps reminder to respond more fully to our November 30, 2018 information request, as it pertains to worst case tidal prism impact and water hyacinth control benefit.

May 28, 2019: Corps provides applicant consultant's follow up response to Service reminder and specifics on information requested, which details smelt catch statistics, closure period, and water hyacinth control/monitoring.

May 30, 2019: Service attends site visit with Corps and applicant consultants (ICF, Peterson-Brustad); consultants further explain extent of proposed water hyacinth control limits.

June 5 and 6, 2019: Service requests further information on Shallow Water Habitat area, water hyacinth removal, tidal prism effect, and costs.

June 13, 2019: Applicant consultant responds to latest Service information request specifying, among other points, that the area of Shallow Water Habitat in Smith Canal is 68 acres; and the approximate extent of water hyacinth control is 4.6 acres.

June 27-28, 2019: Service informs Corps of its decision to treat this consultation as a reinitiation for that part of the Lower San Joaquin River Feasibility Study, and initiates regular conference calls to discuss consultation progress/needs (June 28, July 8, July 22, July 23, August 1).

July 22, 2019: Teleconference. Service staff informs Corps that water hyacinth control is insufficient offset, and that staff will work on specification for what Service would deem sufficient. On behalf of applicant, Corps requests adding a test sheetpile installation in 2019 to this consultation request, and schedules a followup teleconference with applicant's consultant.

July 23, 2019: Teleconference with Corps and applicant consultant; Service staff suggest 6.8 smelt credit purchase to offset gate closure effects on Smith Canal using "equivalence" calculations based on duration of gate operations during smelt spawning season[1].

August 1, 2019: Teleconference. Service and Corps discuss changes to project description, primarily related to credit purchase needed to offset effects to smelt. In consideration of the potential benefit of water hyacinth control in 4.6 acres of Smith Canal which partially overlaps the period of potential smelt occurrence, Service staff suggest further reducing the offset for gate closure effects on Smith Canal to 5.0 acres.

August 5, 2019: Teleconference. Applicant consultant indicates acceptibility of changes to project description regarding credit purchase to offset effects to smelt. Service transmits draft BiOp to Corps with a request for written concurrence with the revised project description.

August 13, 2019: Corps emails Service concurrence with the revised project description.

BIOLOGICAL OPINION

Description of the Action

The action covered by this reinitiation concerns the construction of a tidal gate at Smith Canal as revised based on changes to the Federal nexus (construction through an Army permit), construction and proposed conservation measures for that structure, more detailed information on the construction and effects, additional information provided in response to Service requests (see Consultation History, above), and further Service analysis of this information. Notably, the 2016 LSJRFS BiOp dealt with the effects and conservation measures for the Smith Canal gate within

[1] The mean hours per month of gate closure for the range of smelt spawning (January-July), with 1.66 feet sea level rise, for the modeled period of 1983-2014 is about 43 hours. Assuming this represents, on average, the better part of 9 tidal cycles on different days, it is "equivalent" to 10% of the spawning season rendered inaccessible, and tidal prism loss within and outside of Smith Canal. 6.8 credits is ~10% of the area east of the Smith Canal gate (68 acres at mean high water). The benefit of the credits would be accrued continuously, while the effect of the project operation is discontinuous. Therefore, the credits in this amount are - for this project element action - considered to offset the effect. This calculation was made to frame the magnitude of effect, and is not considered precise. It was later reduced to 5.0 acres on the basis that 4.6 acres of water hyacinth control would have some benefit to smelt.

the combined effects of both Smith Canal and FourteenMile Slough gates. In this reinitiation, we have revised the conservation measures in a way that specifies the conservation measures associated with each gate.

The Service's June 13, 2016, biological opinion for the LSJRFS is hereby amended as follows:

1. CHANGE the following in **Description of the Action,** ***Construction Activities*** on page 6 as follows:

From:

Floodwall

This measure will consist of a sheetpile floodwall from the southern portion of Dad's Point to Louise Park, about 3-4 ft high, possibly with a metal cap or encased in concrete, and 12-18 inches wide. The extent will be 825 ft in length. The improvement at this location may be a berm instead of a floodwall.

To:

Floodwall

This measure will consist of single sheetpile floodwall from the southern portion of Dad's Point to Louise Park, about 3-4 ft high, with a concrete cap, and **about 1 foot wide**. The extent will be 825 ft in length. **Dad's Point would be regraded to cover both sides of the floodwall wherever possible, so that it appears as a raised surface**.

2. CHANGE the following in **Description of the Action,** ***Construction Activities*** on pages 6-7 as follows:

From:

Closure Structure

This measure will involve construction of structures across Smith Canal and Fourteenmile Slough to prevent flooding from the San Joaquin River and Delta; for Fourteenmile Slough, it also will limit the level and duration of water saturation due to higher tides on private levees to the east to reduce the risk of their failure. Each structure will consist of a fixed sheet pile wall structure with an opening gate structure to allow tidal flows and boats to pass when open. A small building has been specified for the Smith Canal structure but since the Fourteenmile Slough structure is a separate, scalable version, it may also require a building. The structure will tie into high ground, either the new berm for the Smith Canal structure or the levee for the Fourteenmile Slough structure. The structures will be routinely closed during any water stage equal to or greater than 8 ft North American Vertical Datum of 1988 (NAVD88) caused by high tides or high tide in combination with rain on snow flood events, as well as during emergency (e.g., failure along Smith Canal and Fourteenmile Slough levees to the east) (see Operation and Maintenance, below). The frequency and duration of gate closure operation is expected to increase during wetter water years, and over the life of the project due to sea level rise.

For portions of the sheetpile to be installed on land, vegetation will be cleared and grubbed for a 35-ft-wide footprint. For the portions of the sheetpile to be installed in water, installation will be done in water using a barge and tug boat. The structure will consist of two parallel sheetpile walls 20 ft apart. The space between the walls will be dewatered and filled with granular fill. Installation of the gate structure and its foundation will be done in the dry by constructing a metal sheet cofferdam for a 70 x 70 ft area. This area will be dewatered. Concrete cylinder piles (24 inch) will be driven inside the cofferdam, then concrete walls and floor, and then the metal miter gate. The gate for each structure will be 50 ft long. Equipment will include a barge, tugboat, vibratory hammer, crane, and vehicles for transporting equipment, material, and personnel.

To:

Closure Structure

This measure will involve construction of structures across Smith Canal and Fourteenmile Slough to prevent flooding from the San Joaquin River and Delta; for Fourteenmile Slough, it also will limit the level and duration of water saturation due to higher tides on private levees to the east to reduce the risk of their failure. Each structure will consist of a fixed sheet pile wall structure with an opening gate structure to allow tidal flows and boats to pass when open. The structure will tie into high ground, either the new berm for the Smith Canal structure or the levee for the Fourteenmile Slough structure. The structures will be routinely closed during any water stage equal to or greater than 8 ft North American Vertical Datum of 1988 (NAVD88) caused by high tides or high tide in combination with rain on snow flood events, as well as during emergency (e.g., failure along Smith Canal and Fourteenmile Slough levees to the east) (see Operation and Maintenance, below). The frequency and duration of gate closure operation is expected to increase during wetter water years, and over the life of the project due to sea level rise.

The Smith Canal gate structure will be constructed first by SJAFCA under an Army permit while the Fourteenmile Slough gate structure will be constructed later by the Corps as part of the Federal project. Specifics for the Smith Canal gate are as follows. For portions of the sheetpile to be installed on land, vegetation will be cleared and grubbed for a 35-ft-wide footprint. For the portions of the sheetpile to be installed in water, installation will be done using a barge and tug boat. **Elements of construction within waters of the United States include the gate structure, the fixed wall, riprap placement, protective elements in the forms of a series of steel pipe piles along the ship channel side of the fixed wall, fender piles on both sides of the gate structure, riprap on both ends of the fixed wall, and several fishing platforms. Other improvements on higher ground at Dad's Point will be done to bring areas up to at least 15 feet NAVD to provide flood risk protection. The total footprint of all permanent impacts to waters of the United States, which is also designated critical habitat for the smelt, will be 0.820 acres.**

> **The fixed wall structure for the Smith Canal gate will consist of two cellular web steel sheet pile walls varying in width from 29 to 34 feet apart.** The space between the walls will be filled with granular fill. Installation of the gate structure and its foundation will be done in the dry by constructing a metal sheet cofferdam for a 70 x 70 ft area. Installation of the cellular sheet pile walls will not require dewatering. Dredging of up to 8,650 cubic yards of channel bottom along the sheet pile wall alignment will be done to provide a level surface. **Steel pipe** piles **(36 inch)** will be driven inside the cofferdam, then concrete walls and floor, and then the metal miter gate. The gate for each structure will be 50 ft long. Equipment will include **barges**, tugboat, vibratory hammer, **impact hammer,** crane, **clamshell excavator or long-arm track hoe, front-end loader,** and vehicles for transporting equipment, material, and personnel.
>
> **Construction of the Smith Canal gate would take slightly more than 2 seasons, beginning in 2019. The sequence of activities for the Smith Canal gate will begin in 2019 with a test installation, and removal, of a single H-pile and sheetpile or pipe pile in three locations along the project alignment that will be completed in up to 3 days within an in-water work window of complete avoidance to smelt (August 1 - November 30), to better specify contracting needs. This initial phase of work in 2019 will be limited to 2,000 strikes per day with an impact hammer. Also in 2019, a cone penetration test (CPT) will be done in up to 7 locations, which only requires pressing a pole-mounted sensor into the channel bottom. The CPTs themselves do not require use of an impact or vibratory hammer. During the next year, beginning within the in-water work window of July 15 - October 15, the cofferdam would be installed for the gate construction (~1 month). Work would continue on the gate and southern portion of the fixed wall until complete and proven operational (~11 months). The year after that, the northern portion of the fixed wall, and all other elements of the project (riprap, dolphins, fender piles, fishing platforms, etc.) would be installed.**

3. CHANGE the following in the first two paragraphs of **Description of the Action,** Erosion Protection, on p. 7, as follows:

From:

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History).

Conventional quarry stone riprap is proposed. A sand filter will be installed prior to riprap placement. Equipment used will be dump or belly dump truck, dozer, and hydraulic excavator. The riprap will be placed in a two-foot-thick layer along the full face of the levee from toe to crown

To:

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History). **Some riprap will be required where the Smith Canal gate floodwall meets higher ground and may also be required similarly for the Fourteenmile Slough gate.**

Conventional quarry stone riprap is proposed. A sand filter will be installed prior to riprap placement. Equipment used will be dump or belly dump truck, dozer, and hydraulic excavator. The riprap will be placed in a two-foot-thick layer along the full face of the levee from toe to crown, **or as specified in plans for gate structures.**

4. ADD the following to the **Description of the Action, Conservation Measures:** Delta Smelt, Avoidance and Minimization Measures, on pages 10-11, to follow the last such measure on page 11, as follows:

Smith Canal gate structure:

The following measures summarize those proposed by the applicant in the October 2018, BA, for permit application SPK-2016-00037:

- In-channel work shall be restricted to low-flow periods between mid-July and mid-October, unless otherwise approved in writing by the Service
- The applicant proposes the following fish protection measures for cofferedam construction and dewatering:
    - a qualified fish biologist will be on site to supervise and document fish rescue;
    - the biologist will determine capture/exclusion measures; oversee monitoring, handling, and release of captured fish; and maintain records of fish rescue activities and environmental conditions.
    - potential methods include seine, net, electrofishing, and others.
- The applicant will require the contractor to implement measures to minimize effects of underwater sound, as described in the BA;
- The applicant will develop and submit a hydroacoustic monitoring plan as described in the BA.

5. CHANGE the following in **Description of the Action, Conservation Measures:** Delta Smelt, Compensation Measures on page 11, as follows:

From:

Compensation Measures

- The Corps proposes to offset the permanent open water impact of an estimated 1 acre, due to construction of the two closures structures by purchase of 3 credits (acres) at a Service-approved conservation bank.

- The Corps proposes to offset the effect of operation of the closure structures on tidal action in an estimated 233 acres combined in Fourteenmile Slough and Smith Canal by purchase of 120 credits (acres) at a Service-approved conservation bank.

To:

Compensation Measures

- The Corps proposes to offset the permanent **impacts of complete loss of shallow water habitat, due to construction of the two closures structures by purchase of credits at a Service-approved conservation bank at a ratio of 3:1 (credits:acres of impact). For the Smith Canal gate, those impacts have been determined to be 0.82 acre, so the credit purchase will be 2.46 acres. The area of the Fourteenmile Slough gate impact is estimated to be 0.7 acre, so the credit purchase will be 2.1 acres**.

- The Corps proposes to offset the **permanent impacts of partial loss of shallow water habitat function within an estimated 68 acres in Smith Canal and 170 acres in Fourteenmile Slough, due to operation of the closure structures on tidal action and habitat access with: (a) for Smith Canal - purchase of 5 credits at a Service-approved conservation bank, and water hyacinth control within 4.6 acres east of the gate to maintain <20% coverage, and (b) for Fourteenmile Slough - purchase of 17 credits (acres) at a Service-approved conservation bank.**

6. CHANGE the following on p. 19, **Action Area** as follows:

From:

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area includes all areas where any type of construction, ETL compliance action, or operation and maintenance action will occur; staging areas and transportation routes used for this construction (not specified at this time); areas to the east of the two closure structures where tidal exchange will be limited by operation of such structures (i.e., Fourteenmile Slough and Smith Canal); the portion of Fourteenmile Slough to the west of the proposed closure structure, where local tidal exchange will also be affected; and the setback area in reach FM_30_L designated for mitigation plantings; and any other mitigation bank sites deemed necessary to offset impacts (i.e., approved conservation banks, not specified at this time).

To:

The action area is defined in 50 CFR § 402.02, as "all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action." For the purposes of the effects assessment, the action area includes all areas where any type of construction, ETL compliance action, or operation and maintenance action will occur; staging areas and transportation routes used for this construction (not specified at this time); areas to the east of the two closure structures where tidal exchange will be limited by operation of such structures (i.e., Fourteenmile Slough and Smith Canal); the portion**s** of Fourteenmile Slough**, Smith Canal, and the San Joaquin River** to the west of the proposed closure structure**s**, where local tidal exchange will also be affected; and the setback area in reach FM_30_L designated for mitigation plantings; and any other mitigation bank sites deemed necessary to offset impacts (i.e., approved conservation banks, not specified at this time).

7. CHANGE the following in **Status of the Species and Environmental Baseline**, <u>Delta Smelt and Critical Habitat Environmental Baseline</u>, last paragraph on p. 21, as follows:

From:

The action area of the proposed project includes tidal waterways of the Delta that are wholly within critical habitat for the species. Adult delta smelt will be expected to migrate from the western Delta into these waterways in the winter and spring months, with typical spawning occurring during April through mid-May, but the species may be present as early as December. Larval smelt will move west in the spring and summer and rear in the low salinity zone. The action area includes shallow subtidal waters that can be used by the species. The project area also includes adjacent levees and vegetation; however, the quality of that habitat for smelt varies with location within the project area and the immediate vicinity. Some portions of the project area include heavily armored channels with limited vegetation on levee slopes or in adjacent shallow water. Other parts of the project area have less armoring and more vegetation growing on the levee slopes. Portions of the action area consist of shallow subtidal waters interspersed with emergent marsh vegetation adjacent to the proposed work; this includes fragments throughout the project area, as well as larger habitat blocks on Fourteenmile Slough both east and west of the proposed closure structure, on the lower Calaveras River, and on French Camp Slough.

To:

The action area of the proposed project includes tidal waterways of the Delta that are wholly within critical habitat for the species. Adult delta smelt will be expected to migrate from the western Delta into these waterways in the winter and spring months, with typical spawning occurring during April through mid-May, but the species may be present as early as December. Larval smelt will move west in the spring and summer and rear in the low salinity zone. The action area includes shallow subtidal waters that can be used by the species. The project area also includes adjacent levees and vegetation; however, the quality of that habitat for smelt varies with location within the project area and the immediate vicinity. Some portions of the project area include heavily armored channels with limited vegetation on levee slopes or in adjacent shallow water. Other parts of the project area have less armoring and more vegetation growing on the levee slopes. Portions of the action area consist of shallow subtidal waters interspersed with emergent marsh vegetation adjacent to the proposed work; this includes fragments throughout the project area, as well as larger habitat blocks on Fourteenmile Slough both east and west of the proposed closure structure, on the lower Calaveras River, and on French Camp Slough. **Water hyacinth accumulates seasonally in some areas of the project, most notably Smith Canal.**

8. CHANGE the following in **Effects of the Action,** Delta Smelt beginning with the first full paragraph on p. 25, as follows:

From:

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in a combined permanent loss of 1 acre of SWH and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance. Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of 233 acres of SWH in waters isolated by the structures (66 acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[2]).

To:

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in permanent **losses of 0.82 acre (Smith Canal gate) and 0.70 acre (Fourteenmile Slough gate) of SWH** and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance (i.e., begin before August 1). Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of **238** acres of SWH in waters isolated by the structures (**68** acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[3]).

9. CHANGE the following in **Effects of the Action,** Delta Smelt beginning with the third full paragraph on p. 26, as follows:

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[2] Service rough estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion it is assumed that all surface water in these eastern channel areas falls within the SWH limits discussed in this section.

[3] Estimate for area east of Smith Canal gate from Applicant (See Consultation History, June 13, 2019); Estimate for area east of Fourteenmile Slough gate is a Service-generated estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion it is assumed that all surface water areas east of both proposed gates falls within the SWH limits discussed in this section.

From:

Benefits to delta smelt will accrue from the purchase of 123 credits from a Service-approved conservation bank. The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. For this reason, we believe that the 123 credits proposed are appropriate compensation for the effects on the 233 acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

To:

Benefits to delta smelt will accrue from the purchase of **26.56** credits from a Service-approved conservation bank **(7.46 credits for Smith Canal gate; 19.1 credits for FourteenMile Slough gate)**. The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. **The proposed water hyacinth control will provide limited benefits to delta smelt within a portion of Smith Canal only. This control is expected to be done during the March-December hyacinth growing season, which overlaps part of the spawning season of smelt. Water hyacinth can shield predators of smelt, and it can also result in diminished water quality due to increased organic matter and reduced light. These factors could affect smelt and will be partially ameliorated by the control measure.** For these reasons, we believe that the **26.56** credits proposed are appropriate compensation for the effects on the **238** acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

10. CHANGE the following in **Effects of the Action**, <u>Delta Smelt Critical Habitat</u>, p. 27, second and third paragraphs, as follows:

From:

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about 1 acre and temporarily affect 3 acres. These effects will be offset through the purchase of 3 credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on 233 acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of 120 credits at a delta smelt conservation bank.

To:

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about **1.52** acre and temporarily affect 3 acres. These effects will be offset through the purchase of **4.56** credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on **238** acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of **26.56** credits at a delta smelt conservation bank.

11. CHANGE the following in **Amount or Extent of Take**, Delta Smelt, on p. 31, as follows:

From:

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in 4 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (1 acre of fill in the footprints of the closure structures; 3 acres of temporary loss in the construction area of the closure structures).

As for the effect of tidal gate operations on the 233 acres of SWH east of the closure structures that would be seasonally and diurnally affected by gate operation, incidental take of delta smelt will be difficult to evaluate directly. Because of the extremely low population of the species, sampling is unlikely to detect smelt even if they were present. Any such detections will mean that take is occurring and our analysis requires re-evaluation. Initially, the Corps will develop and conduct a fixed term of focused pre- and post-project sampling within the affected sloughs required as a term and condition of this biological opinion. We acknowledge that the effects are partial, and would be offset by purchase of credits. We anticipate incidental take of two (2) adult or juvenile delta smelt for the area affected by the closure structures. Detection of two adult or juvenile delta smelt in Smith Canal or Fourteenmile Slough during the focused sampling by the Corps, or within these waters by other independent sampling after the project has been completed, will mean that the smelt is being or could be affected by the project in excess of the expected effects in these locations.

To:

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in **4.52** acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (**1.52** acre of fill in the footprints of the closure structures; 3 acres of temporary loss in the construction area of the closure structures).

As for the effect of tidal gate operations on the **238** acres of SWH east of the closure structures that would be seasonally and diurnally affected by gate operation, incidental take of delta smelt will be difficult to evaluate directly. Because of the extremely low population of the species, sampling is unlikely to detect smelt even if they were present. Any such detections will mean that take is occurring and our analysis requires re-evaluation. Initially, the Corps will develop and conduct a fixed term of focused pre- and post-project sampling within the affected sloughs required as a term and condition of this biological opinion. We acknowledge that the effects are partial, and would be offset by purchase of credits. We anticipate incidental take of two (2) adult or juvenile delta smelt for the area affected by the closure structures. Detection of two adult or juvenile delta smelt in either Smith Canal or Fourteenmile Slough during the focused sampling **required** by the **Corps or Applicant under Term and Condition #3, and reported under Reporting Requirement #4c,** or **detected** within these waters by other independent sampling after the project has been completed, will mean that the smelt is being or could be affected by the project in excess of the expected effects in these locations.

12. CHANGE the following in **Terms and Conditions**, on p. 33, as follows:

From:

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: (a) a pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically (i) areas of upland and aquatic habitat for the snake, (ii) numbers of elderberry shrubs and stems in the diameter classes considered habitat for the beetle in accordance with the Conservation Guidelines, and (iii) areas of Shallow Water Habitat as habitat for the smelt affected by the project including the footprint of proposed gate structures, the operational periods of such gates, and the area(s) isolated by such gates; (b) a cumulative accounting of the effects on listed species habitat of all phases constructed to date; (c) a narrative describing how the already constructed plus additional proposed work effects fall within the take limits described in this biological opinion; (d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction; (e) its approved ETL variance for that phase, with a narrative explaining how it is consistent with the project

description of this biological opinion, and a determination that the effects are within the parameters of allowable take; (f) detailed survey protocols for implementing those measures shown in Appendix A of this biological opinion; and (g) a request to the Service for written concurrence with items 1(c) ,1(e), and 1(f). If the Service concurs, we shall issue a letter of concurrence and the Corps may proceed with construction and OMRRR under this biological opinion. If we do not concur, we will specify our reasons and the Corps must re-initiate formal consultation.

In order to accurately estimate take, the Corps shall resurvey areas with pending construction for elderberry shrubs no sooner than one year prior to the onset of that construction.

To:

1. For each discrete phase or construction contract, after designs are completed but before commencement of construction, the Corps **or Applicant, as appropriate,** will submit to the Service: (a) a pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically (i) areas of upland and aquatic habitat for the snake, (ii) numbers of elderberry shrubs and stems in the diameter classes considered habitat for the beetle in accordance with the Conservation Guidelines, and (iii) areas of Shallow Water Habitat as habitat for the smelt affected by the project including the footprint of proposed gate structures, the operational periods of such gates, and the area(s) isolated by such gates; (b) a cumulative accounting of the effects on listed species habitat of all phases constructed to date; (c) a narrative describing how the already constructed plus additional proposed work effects fall within the take limits described in this biological opinion; (d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction; (e) its approved ETL variance for that phase, with a narrative explaining how it is consistent with the project description of this biological opinion, and a determination that the effects are within the parameters of allowable take; (f) detailed survey protocols for implementing those measures shown in Appendix A of this biological opinion; and (g) a request to the Service for written concurrence with items 1(c) ,1(e), and 1(f). If the Service concurs, we shall issue a letter of concurrence and the Corps may proceed with construction and OMRRR under this biological opinion. If we do not concur, we will specify our reasons and the Corps must re-initiate formal consultation.

   In order to accurately estimate take, the Corps **or Applicant, as appropriate,** shall resurvey areas with pending construction for elderberry shrubs no sooner than one year prior to the onset of that construction.

13. CHANGE the following in **Terms and Conditions**, on p. 34, as follows:

From:

3. The Corps will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the

complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work.

4. The Corps will prepare and submit to the Service for approval, a sampling plan designed to detect any delta smelt that may be using Smith Canal or Fourteenmile Slough. The general parameters of this sampling are that it should be limited to three seasons, of which at least two seasons will be before project construction, and the post-construction sampling is to be conducted no later than three years after construction. This plan must be approved by the Service in writing prior to the onset of monitoring.

To:

3. The Corps **or Applicant, as appropriate** will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work**, with the exception of the Smith Canal gate test sheetpile installation in 2019.**

4. The Corps **or Applicant, as appropriate** will prepare and submit to the Service for approval, a sampling plan designed to detect any delta smelt that may be using Smith Canal or Fourteenmile Slough. The general parameters of this sampling are that it should be limited to three seasons, of which at least **one season** will be before project construction **of the gate element in each location**, and the post-construction sampling is to be conducted no later than three years after construction. **The plan should be focused on enhanced detection of smelt in these locations, using the most sensitive methods that can be reasonably implemented, and done at times and under conditions with the highest likelihood of smelt presence.** This plan must be approved by the Service in writing prior to the onset of monitoring.

14. CHANGE the following in *Reporting Requirements*, beginning on p. 35, as follows:

From:

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to the following monitoring requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-5604, and must include the date, time, and precise location of the

individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps (during construction) or the local sponsor (during maintenance) shall follow the steps outlined in the Disposition of Individuals Taken section below. The Corps shall incorporate this notification information as a requirement in the OMRRR.

2. The Corps will document, monitor, and report the actual amount of take of listed species and listed species habitat for project construction of each discrete phase or contract of the project, and submit a post-construction monitoring report within 180 days of completion. This document will include: (a) photo-documentation immediately before construction, and after completion of construction; (b) a comparison of the as-built effects on listed species habitat with that described in Term and Condition No. 1; and (c) a summary table of construction monitoring to verify that the monitoring extent and frequency are consistent with that proposed, the sightings of any listed species, and any observed effect on habitat beyond that described in the design.

3. The Corps will develop a requirement in its OMRRR manual for the local sponsor to maintain a record of operations and maintenance activities as they affect listed species and reporting of such in an annual report to the Service. The report will cover calendar year activities, and be submitted to the Service by March 1 of the year following. This requirement will include a record of the dates, types, locations, areas, and frequencies of maintenance activities, extent of compliance with conservation measures in this biological opinion associated with maintenance, and the take of any listed species or lack thereof. Example parameters may include areas mowed within 30 ft of snake habitat, a tally of the number of rodent holes grouted within 30 ft of snake habitat in particular areas, the number of elderberry shrubs present, avoided, trimmed, or removed, and so on. The Corps will provide a draft of this requirement to the Service for review and concurrence that it adequately documents the effect of maintenance on listed species. If the Service concurs, the Corps may proceed with finalizing its OMRRR manual. If we do not concur, we will specify our reasons and alternative language that fulfills this need.

4. Additional Reporting: Within 90 days of completion of the last data collection of the year for each monitoring requirement, the Corps will submit (a) baseline and annual reports of the health and condition of elderberry shrubs not directly affected, but within 100 ft of project work (one baseline and two post-construction reports per construction phase); and any associated additional mitigation; (b) preconstruction and, at 5-year intervals until construction is complete, reports documenting quantities of alternative snake refugia; and (c) pre- and post-construction reports of delta smelt sampling in Fourteenmile Slough and Smith Canal.

To:

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the project is approached or exceeded, the Corps shall adhere to**, or require the Applicant to adhere to as appropriate,** the following monitoring requirements. Should this anticipated amount or extent of incidental take be exceeded, the Corps must reinitiate formal consultation as per 50 CFR 402.16.

1. The Service must be notified within one (1) working day of the finding of any injured or dead listed species or any unanticipated damage to its habitat associated with the proposed project. Notification will be made to the Assistant Field Supervisor of the Endangered Species Program at the Bay Delta Fish and Wildlife Office at (916) 930-**266**4, and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual of the listed species is found, the Corps (during construction) or the local sponsor (during maintenance) shall follow the steps outlined in the Disposition of Individuals Taken section below. The Corps shall incorporate this notification information as a requirement in the OMRRR.

2. The Corps **or Applicant, as appropriate** will document, monitor, and report the actual amount of take of listed species and listed species habitat for project construction of each discrete phase or contract of the project, and submit a post-construction monitoring report within 180 days of completion. This document will include: (a) photo-documentation immediately before construction, and after completion of construction; (b) a comparison of the as-built effects on listed species habitat with that described in Term and Condition No. 1; and (c) a summary table of construction monitoring to verify that the monitoring extent and frequency are consistent with that proposed, the sightings of any listed species, and any observed effect on habitat beyond that described in the design.

3. The Corps will develop a requirement in its OMRRR manual for the local sponsor **or Applicant, as appropriate** to maintain a record of operations and maintenance activities as they affect listed species and reporting of such in an annual report to the Service. The report will cover calendar year activities, and be submitted to the Service by March 1 of the year following. This requirement will include a record of the dates, types, locations, areas, and frequencies of maintenance activities, extent of compliance with conservation measures in this biological opinion associated with maintenance, and the take of any listed species or lack thereof. Example parameters may include areas mowed within 30 ft of snake habitat, a tally of the number of rodent holes grouted within 30 ft of snake habitat in particular areas, the number of elderberry shrubs present, avoided, trimmed, or removed, and so on. The Corps will provide a draft of this requirement to the Service for review and concurrence that it adequately documents the effect of maintenance on listed species. If the Service concurs, the Corps may proceed with finalizing its OMRRR manual. If we do not concur, we will specify our reasons and alternative language that fulfills this need.

4. Additional Reporting: Within 90 days of completion of the last data collection of the year for each monitoring requirement, the Corps will submit, **or require the Applicant to submit, as appropriate:** (a) baseline and annual reports of the health and condition of elderberry shrubs not directly affected, but within 100 ft of project work (one baseline and two post-construction reports per construction phase); and any associated additional mitigation; (b) preconstruction and, at 5-year intervals until construction is complete,

reports documenting quantities of alternative snake refugia; and (c) pre- and post-construction reports of delta smelt sampling in Fourteenmile Slough and Smith Canal.

REINITIATION—CLOSING STATEMENT

This concludes this reinitiation of formal consultation on the Lower San Joaquin River Feasibility Study; Smith Canal Gate SPK-2016-00037. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this reinitiation, please contact Steven Schoenberg of my staff at (916) 930-5672.

Sincerely,

Kaylee Allen
Field Supervisor

cc:

Chandra Jenkins, Corps of Engineers, Sacramento, CA
Tanis Toland, Corps of Engineers, Sacramento, CA
Howard Brown, National Marine Fisheries Service, Sacramento, CA
Jeff Drongesen, Region II, California Department of Fish and Wildlife, Sacramento, CA
Jim Starr, Region III, California Department of Fish and Wildlife, Stockton, CA
Ruth Darling, Department of Water Resources, Sacramento, CA
Chris Elias, San Joaquin Area Flood Control Agency, Stockton, CA

United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer To:
2022-0043398

Mr. Kevin Harper
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
Sacramento, California 95814-2922

Subject: Reinitiation of formal consultation on the Lower San Joaquin River Feasibility Study, San Joaquin County, California; Smith Canal Gate SPK-2016-00037

Dear: Mr. Harper:

This is in response to the U.S. Army Corps of Engineers' (Corps) March 16, 2023, letter requesting reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on issuance of an Army permit for the Smith Canal Gate Project (project). The project for which you are requesting consultation is an element of the Lower San Joaquin River Feasibility Study (LSJRFS) Recommended Plan, San Joaquin County, California, for which a Biological Opinion (BiOp) was originally issued on June 13, 2016, and a reinitiation issued on August 19, 2019. The LSJRFS is a Federal project with the Corps as the Federal lead agency and the Central Valley Flood Protection Board and the San Joaquin Area Flood Control Agency (SJAFCA) as the non-Federal local sponsors partnering with the Corps. The LSJRFS consists of improvements to 24 miles of levees in the Central and North Stockton areas to address seepage, slope stability, overtopping, and erosion concerns. Under the permit that is the subject of this consultation request, the Smith Canal Gate element would be constructed by SJAFCA as the applicant, instead of by the Corps, with SJAFCA as the local sponsor.

At issue are effects of the project on the federally-listed as threatened delta smelt (*Hypomesus transpacificus*), and delta smelt critical habitat. Your request was received on March 16, 2023, with a supplemental Biological Assessment (Biological Assessment Supplement for the Smith Canal Gate Project, San Joaquin County, California, prepared by ECORP Consulting, Inc., Rocklin, California, March 2023; hereafter "supplemental BA"). The changes described in your request and the supplemental BA involve: (1) placement of 0.386-acre of Rock Slope Protection (RSP) in the vicinity of the miter gate; (2) Thirteen additional Cone Penetration Tests (CPT); (3) warranty testing and any identified repairs; (4) additional seasons, extending now to 2023-2026, as well as a longer work window in each season (July 1 – November 30) for various construction elements not yet completed, warranty testing, and repair; and (5) supplemental mitigation for effects of the RSP on Shallow Water Habitat (SWH) available for use by delta smelt.

As with the first reinitiation, we have again decided to treat your latest request as a reinitiation of formal consultation of the LSJRFS and to amend our 2016 BiOp as appropriate. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq*.) (ESA), and is to be considered sufficient for the additional purpose of consultation on the issuance of an Army permit.

CONSULTATION HISTORY

A detailed consultation history since our August 19, 2019, reinitiation is provided in the supplemental BA included with your request, and incorporated here by reference. Since then, prior the current reinitiation, we have provided technical assistance in the form of approving Fishery Protection Plans with associated measures to allow early work starts in 2020-2021, and participated in several calls to discuss this latest request. Since receipt of the current reinitiation, further communications were made to verify credit purchases intended to be applied to the additional effects of RSP impacts described in this reinitiation. Most recent events include:

March 16, 2023: Service receives electronic mail request from the Corps reinitiating formal consultation on the Smith Canal Gate Project.

March 20 and 21, 2023: Steve Schoenberg (Service staff) emails applicant's consultant agent Jeff Tupen of ECORP asking for summary of SJAFCA's purchase of mitigation credits to date on the Smith Canal Gate Project.

March 23, 2023: Multiple emails between Jeff Tupen and Steve Schoenberg to itemize SJAFCA's prior purchase of Project mitigation credits. SJAFCA purchased 13.69 mitigation credits to mitigate for impacts to riverine and riparian habitats at the Smith Canal Gate Project, as follows:

1. 6.96 smelt/salmonid restoration credits at Liberty Island
2. 1.5 salmonid preservation credits at Liberty Island
3. 0.81 salmonid restoration credit at Liberty Island
4. 1.93 salmonid preservation credits at Liberty Island
5. 2.48 floodplain mosaic wetland restoration credits at Cosumnes Floodplain Mitigation Bank
6. 0.01 floodplain riparian habitat restoration credit at Cosumnes Floodplain Mitigation Bank

The emails explain that the first two transactions listed (6.96 smelt/salmonid credits and 1.5 salmonid credits [total of 8.46 credits] at Liberty Island) were purchased by SJAFCA to offset 0.82-acre of direct permanent impact (fill resulting in loss of SWH) and 68 acres of indirect permanent impacts (long-term Project O&M effects) to delta smelt habitat. The "excess credits" purchased to satisfy permitting requirements of agencies other than USFWS (i.e., 2.49 riparian credits and 2.74 salmonid credits) are not delta smelt credits and are therefore considered to be "out of kind" if they were to be credited to future/additional delta smelt mitigation needs (e.g., for offsetting SWH impacts from placement of 0.39-acre of RSP and consequent reduced SWH value around the gate foundation).

March 31, 2023: Email from Steve Schoenberg to Jeff Tupen asking SJAFCA to: (1) clarify its mitigation proposal for compensating for directly and permanently diminishing the value of 0.39-acre of SWH with the placement of RSP around the miter gate foundation; and (2) provide proof of purchase for project mitigation credits secured by SJAFCA to date.

April 3, 2023: Email from Jeff Tupen to Steve Schoenberg proposing that USFWS accept 2.74 salmonid credits previously purchased by SJAFCA to offset 0.39-acre of reduced SWH function with placement of RSP around the gate foundation, and approximately 7:1 mitigation ratio.

April 3, 2023: Email from Steve Schoenberg to Jeff Tupen to verify accounting of 19.3 bank limit of use of salmonid preservation credit for offset of delta smelt impact.

April 5, 2023: Email from Jeff Tupen to Steve Schoenberg with attached proof of purchase of 1.93 salmonid preservation credits and 0.81 salmonid restoration credit at Liberty Island Conservation Bank.

April 12, 2023: Email from Jeff Tupen to Steve Schoenberg with attached Liberty Island Conservation Bank ledger from bank manager Peggy Lee of RES showing 1.93 credits used to offset State requirements for this action under CESA/LSAA (California Endangered Species Act/Lake and Streambed Alteration Agreement) not previously assigned to this consultation (ledger entry LICB -20-77).

April 13, 2023: Email from Jeff Tupen to Steve Schoenberg with narrative explanation and justification of applicant's mitigation proposal, along with two attachments: (1) Exhibit F-1 from the 2010 Liberty Island Conservation Bank Agreement; and (2) an undated document from RES on the benefits of the seasonally inundated floodplain to delta smelt. Tupen notes that the 19.3 salmonid preservation credits which could be assigned for delta smelt were sold out at the time this consultation was written, corresponding to the 19.3 acres of tidal channels in the bank.

The email notes that in 2020 the Service had accepted further salmonid preservation credits in the bank beyond the 19.3 bank agreement allowance, those associated with the seasonally inundated floodplain, to offset a minor portion of delta smelt impacts of this project out-of-kind at a higher ratio. The email proposes that only the 1.93 salmonid preservation credits purchased by applicant above and beyond federal ESA requirements to satisfy CDFW permitting requirements for this same project, be assigned as mitigation for the 0.386 acres of RSP placement around the gate structure (5:1 ratio). This is proposed to fulfill the 1.16 delta smelt credit purchase need proposed in the supplemental BA.

BIOLOGICAL OPINION

Description of the Action

The action covered by this reinitiation concerns the construction of a floodwall and tidal gate at Smith Canal as revised based on changes to the Federal nexus (construction through an Army permit), specifically, the number of CPTs, the precise quantity of RSP, additional mitigation associated with the RSP, additional seasons for construction and warranty testing, and a longer work window within each season.

Unlike the last reinitiation, which modified ESA compensation requirements for both the Smith Canal and Fourteenmile Slough gates, this reinitiation is specific only to Smith Canal Gate.

After review of the supplemental BA, our June 13, 2016, biological opinion for the LSJRFS, as modified in our August 19, 2019, reinitiation is hereby further amended as follows (additional or modified text is shown in **boldface**):

1. CHANGE the following in fourth paragraph of **Description of the Action, *Construction Activities*,** **Closure Structure** (August 19, 2019, reinitiation p. 4):

From:

> Construction of the Smith Canal gate would take slightly more than 2 seasons, beginning in 2019. The sequence of activities for the Smith Canal gate will begin in 2019 with a test installation, and removal, of a single H-pile and sheetpile or pipe pile in three locations along the project alignment that will be completed in up to 3 days within an in-water work window of complete avoidance to smelt (August 1 - November 30), to better specify contracting needs. This initial phase of work in 2019 will be limited to 2,000 strikes per day with an impact hammer. Also in 2019, a cone penetration test (CPT) will be done in up to 7 locations, which only requires pressing a pole-mounted sensor into the channel bottom. The CPTs themselves do not require use of an impact or vibratory hammer. During the next year, beginning within the in-water work window of July 15 - October 15, the cofferdam would be installed for the gate construction (~1 month). Work would continue on the gate and southern portion of the fixed wall until complete and proven operational (~11 months). The year after that, the northern portion of the fixed wall, and all other elements of the project (riprap, dolphins, fender piles, fishing platforms, etc.) would be installed.

To:

> Construction of the Smith Canal gate would take approximately **8** seasons, beginning in 2019. The sequence of activities for the Smith Canal gate will begin in 2019 with a test installation, and removal, of a single H-pile and sheetpile or pipe pile in three locations along the project alignment that will be completed in up to 3 days within an in-water work window of complete avoidance to smelt (August 1 - November 30), to better specify contracting needs. This initial phase of work in 2019 will be limited to 2,000 strikes per day with an impact hammer. Also in 2019, a cone penetration test (CPT) will be done in up to 7 locations, which only requires pressing a pole-mounted sensor into the channel bottom. The CPTs themselves do not require use of an impact or vibratory hammer. **During 2020, beginning within the in-water work window of July 1 - November 30, the cofferdam would be installed for the gate construction (~1 month). In 2021, work would continue on the gate, the southern portion of the fixed wall, and other minor elements. In 2022, work will continue on the gate structure, northern and southern floodwall cells including placement of granular fill, and installation of fishing pier decks.**
>
> **In 2023-2026, all remaining work would be done. This will begin with up to 13 additional CPTs in 2023, and continue in 2023-2024 with completion of installation**

> **of the gate, all remaining north and south floodwall cells, and associated granular fill. After completion of these elements, the ring cofferdam will be removed, the RSP footprint dredged around the gate foundation, RSP placed, and other minor features installed. Following completion, there will be two seasons of warranty inspection (2024-2025), with warranty repairs to occur the season following inspection (2025-2026). Dates are approximate; however, all activities are anticipated to be done by the end of the in-water work window in 2026.**

2. CHANGE the following in the first paragraph of Description of the Action, Erosion Protection (August 19, 2019, reinitiation p. 6) as follows:

From:

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History). Some riprap will be required where the Smith Canal gate floodwall meets higher ground and may also be required similarly for the Fourteenmile Slough gate.

To:

This measure involves placement of rock slope protection; mostly to be installed on the land side of the Delta Front levees (Shima Tract, Tenmile Slough) to protect them from wave runup should the agricultural levees to the west fail during a flood event. Erosion protection for part of Duck Creek to protect the landside of the levee from floodwaters moving north which might wrap around the end of the levee is no longer proposed (see Consultation History). Some riprap (also known as rock slope protection, or RSP) will be required where the Smith Canal gate floodwall meets higher ground and in the vicinity of its miter gate, and may also be required similarly for the Fourteenmile Slough gate. **For the miter gate at Smith Canal, the canal bottom would be dredged 1-10 feet below canal bottom elevation before placing RSP. The increment of shallow water habitat affected by RSP placement associated with this miter gate is 0.39-acre.**

3. CHANGE the following in **Description of the Action, Conservation Measures:** Delta Smelt, Compensation Measures (August 19, 2019, reinitiation p.8), as follows:

From:

Compensation Measures

- The Corps proposes to offset the permanent impacts of complete loss of shallow water habitat, due to construction of the two closures structures by purchase of credits at a Service-approved conservation bank at a ratio of 3:1 (credits:acres of impact). For the Smith Canal gate, those impacts have been determined to be 0.82 acre, so the credit purchase will be 2.46 acres. The area of the Fourteenmile Slough gate impact is estimated to be 0.7 acre, so the credit purchase will be 2.1 acres.

- The Corps proposes to offset the permanent impacts of partial loss of shallow water habitat function within an estimated 68 acres in Smith Canal and 170 acres in Fourteenmile Slough, due to operation of the closure structures on tidal action and habitat access with: (a) for Smith Canal - purchase of 5 credits at a Service-approved conservation bank, and water hyacinth control within 4.6 acres east of the gate to maintain <20% coverage, and (b) for Fourteenmile Slough - purchase of 17 credits (acres) at a Service-approved conservation bank.

To:

Compensation Measures

- The Corps proposes to offset the permanent impacts of complete loss of shallow water habitat, due to construction of the two closures structures by purchase of credits at a Service-approved conservation bank at a ratio of 3:1 (credits:acres of impact). For the Smith Canal gate, those impacts have been determined to be 0.82 acre, so the credit purchase will be 2.46 acres. **Also, for Smith Canal gate, the Corps has identified a degradation of shallow water habitat quality associated with placement of 0.39 acre of RSP in the vicinity of the miter gate. For this loss, the Corps proposes to apply a 3:1 ratio and purchase an additional 1.16 credits.** The area of the Fourteenmile Slough gate impact is estimated to be 0.7 acre, so the credit purchase will be 2.1 acres.

- The Corps proposes to offset the permanent impacts of partial loss of shallow water habitat function within an estimated 68 acres in Smith Canal and 170 acres in Fourteenmile Slough, due to operation of the closure structures on tidal action and habitat access with: (a) for Smith Canal - purchase of 5 credits at a Service-approved conservation bank, and water hyacinth control within 4.6 acres east of the gate to maintain <20% coverage, and (b) for Fourteenmile Slough - purchase of 17 credits (acres) at a Service-approved conservation bank.

4. CHANGE the following in **Effects of the Action,** Delta Smelt (August 19, 2019, reinitiation p. 10, paragraph under CHANGE #8), as follows:

From:

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in permanent **losses** of 0.82 acre (Smith Canal gate) and 0.70 acre (Fourteenmile Slough gate) of SWH and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance (i.e., begin before August 1). Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of 238 acres of SWH in waters isolated by the structures (68 acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[1]).

To:

Construction of the two closure structures will directly affect delta smelt in two ways - direct loss of habitat from construction, and effects on the smelt and its critical habitat through gate operations. First, the structures and construction cofferdams needed for their construction at the mouth of Smith Canal and at the location on Fourteenmile Slough will result in permanent losses of **1.21 acres** (Smith Canal gate and floodwall**, including RSP**) and 0.70 acre (Fourteenmile Slough gate) of SWH and combined temporary loss of 3 acres. Smelt may be affected by construction because the work must occur slightly outside of the seasonal window for complete avoidance (i.e., begin before August 1). Second, operation of the structures will intermittently prevent tidal flows and reduce the availability and use of 238 acres of SWH in waters isolated by the structures (68 acres east of the Smith Canal structure; 170 acres east of the Fourteenmile Slough Structure[2]).

5. CHANGE the following in **Effects of the Action,** <u>Delta Smelt</u> (August 19, 2019, reinitiation p. 10, paragraph under CHANGE #9):

From:

Benefits to delta smelt will accrue from the purchase of 26.56 credits from a Service-approved conservation bank (7.46 credits for Smith Canal gate; 19.1 credits for FourteenMile Slough gate). The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. The proposed water hyacinth control will provide limited benefits to delta smelt within a portion of Smith Canal only. This control is expected to be done during the March-December hyacinth growing season, which overlaps part of the spawning season of smelt. Water hyacinth can shield predators of smelt, and it can also result in diminished water quality due to increased organic matter and reduced light. These factors could affect smelt and will be partially ameliorated by the control measure. For these reasons, we believe that the 26.56 credits proposed are appropriate compensation for the effects on the 238 acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

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[1] Estimate for area east of Smith Canal gate from Applicant (See Consultation History, June 13, 2019); Estimate for area east of Fourteenmile Slough gate is a Service-generated estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion it is assumed that all surface water areas east of both proposed gates falls within the SWH limits discussed in this section.

[2] Estimate for area east of Smith Canal gate from Applicant (See Consultation History, June 13, 2019); Estimate for area east of Fourteenmile Slough gate is a Service-generated estimate based on digitizing of aquatic habitat visible on 2014 NAIP imagery overlain by project plan shapefile; this did not consider bathymetry; for the purposes of this discussion, it is assumed that all surface water areas east of both proposed gates falls within the SWH limits discussed in this section.

To:

Benefits to delta smelt will accrue from the purchase of **27.72** credits from a Service-approved conservation bank (**8.62** credits for Smith Canal gate; 19.1 credits for Fourteenmile Slough gate). The proposed habitat compensation will provide benefits commensurate with or better than the permanent losses of habitat, either due to conversion, or due to partial loss of habitat function from gate operation. Those benefits will be accrued throughout the project life beginning with credit purchase before or concurrent with construction of the closure structures, well before the majority of anticipated effects due to the increased frequency of gate operation with sea level rise. The proposed water hyacinth control will provide limited benefits to delta smelt within a portion of Smith Canal only. This control is expected to be done during the March-December hyacinth growing season, which overlaps part of the spawning season of smelt. Water hyacinth can shield predators of smelt, and it can also result in diminished water quality due to increased organic matter and reduced light. These factors could affect smelt and will be partially ameliorated by the control measure. For these reasons, we believe that the **27.72** credits proposed are appropriate compensation for the effects on the 238 acres of tidal open water and included SWH. These lands and waters in the purchased credits will contribute to the smelt's recovery by securing habitat that is protected from development and other threat factors.

6. CHANGE the following in **Effects of the Action**, <u>Delta Smelt Critical Habitat</u>, (August 19, 2019, bottom of p. 11):

From:

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about 1.52 acre and temporarily affect 3 acres. These effects will be offset through the purchase of 4.56 credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on 238 acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of 26.56 credits at a delta smelt conservation bank.

To:

Implementation of the proposed project will affect PCE #1 Physical Habitat as described under the environmental baseline section above. Construction of the gate structures will result in the permanent loss of shallow water habitat of about 1.52 **acres**, **degradation of 0.386 acre,** and temporarily affect 3 acres. These effects will be offset through the purchase of 4.56 credits at a delta smelt conservation bank.

Operation of the gate structures will result in partial effects primarily on 238 acres of habitat east of the closure structures (Effects of the Action - Delta Smelt). There would also be some increment of effect of gate structure operation on tidal functions and values in connected waterways outside the project area that are part of critical habitat. These effects would be considered offset by the purchase of **27.72 credits** at a delta smelt conservation bank.

7. CHANGE the following in **Amount or Extent of Take**, Delta Smelt, (August 19, 2019, reinitiation p. 11):

From:

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in 4.52 acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (1.52 acre of fill in the footprints of the closure structures; 3 acres of temporary loss in the construction area of the closure structures).

To:

The Service expects that incidental take of delta smelt will be difficult to detect or quantify for the following reasons: the small size of adults and larvae, the difficulty of detecting delta smelt in their turbid aquatic habitat, and the low likelihood of finding dead or impaired specimens. The Service anticipates that the extent of incidental take will be minimized due to the proposed conservation measures and low relative abundance. Due to the difficulty in quantifying the number of delta smelt that will be taken as a result of the proposed action, the number of acres of affected habitat becomes a surrogate for the species that will be taken. The Service anticipates that all individual adult delta smelt in **4.91** acres of the action area may be subject to incidental take in the form of harm as described in this biological opinion (1.52 acre of fill in the footprints of the closure structures; **placement of 0.39 acre of RSP around the gate foundation**, and 3 acres of temporary loss in the construction area of the closure structures).

8. CHANGE the following in **Terms and Conditions** (August 19, 2019, reinitiation, bottom of p. 14):

From:

3. The Corps or applicant, as appropriate will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work, with the exception of the Smith Canal gate test sheetpile installation in 2019.

To:

3. **For work prior to 2023,** the Corps or applicant, as appropriate will prepare and submit to the Service for approval, a fisheries protection plan to monitor and protect delta smelt that may be affected by in-water work outside of the complete avoidance window of August 1 to November 30. Aspects of the plan may include screening, monitoring, fish salvage methods, and reporting. This plan must be approved by the Service in writing prior to the onset of work, with the exception of the Smith Canal gate test sheetpile installation in 2019. **For work in 2023-2026, in-water work will be permitted between July 1 and November 30 without further submittal and approval of a fisheries protection plan, provided that the Corps requires the applicant to apply measures in the last previously approved fisheries protection plan for 2021.**

For the purpose of this reinitiation, the Service concurs that the 1.93 salmonid preservation credits previously purchased are sufficient meet the 1.16 acres of delta smelt credit purchase need specified in the supplemental BA for offset of additional impacts of RSP placement. Term and Condition 1 outlines a process to account for listed species habitat impacts and verification of credit purchase and concurrence from the Service that this is accurate and accomplished prior to first impact of a discrete phase. The materials and communications received in this reinitiation have revised the impact of listed species habitat, specifically Shallow Water Habitat, as required under Term and Condition 1(a)(iii), and revised the cumulative accounting of such impact as required under Term and Condition 1(b). This reinitiation response revises the take limit to allow for this increased impact, so Term and Condition 1(c) is also met. Applicant has recently provided documentation of acquisition of the additional credits purchased for this project for State purposes, and no prior assignment to offset impacts to delta smelt under the ESA, meeting Term and Condition 1(d). Term and Conditions 1(e) and 1(f) are not applicable to this reinitiation. Because of this record, it is not necessary for the applicant to request further concurrence from the Service under Term and Condition 1(g) prior to further construction.

REINITIATION—CLOSING STATEMENT

This concludes this reinitiation of formal consultation on the Lower San Joaquin River Feasibility Study; Smith Canal Gate SPK-2016-00037. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this reinitiation, please contact Steven Schoenberg of my staff at (916) 930-5672 or at Steven_Schoenberg@fws.gov.

Sincerely,

DONALD RATCLIFF Digitally signed by DONALD RATCLIFF Date: 2023.05.17 11:21:17 -07'00'

Donald Ratcliff
Field Supervisor

cc:

Matt Hirkala, Corps of Engineers, Sacramento, CA
Tanis Toland, Corps of Engineers, Sacramento, CA
Howard Brown, National Marine Fisheries Service, Sacramento, CA
Jeff Drongesen, Region II, California Department of Fish and Wildlife, Sacramento, CA
Melissa Farinha, Region III, California Department of Fish and Wildlife, Stockton, CA
Ruth Darling, Department of Water Resources, Sacramento, CA
Chris Elias, San Joaquin Area Flood Control Agency, Stockton, CA
Jeff Tupen, ECORP Consulting, Inc., Rocklin, CA

Sincerely,

DONALD RATCLIFF

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Date: 2023.05.17 11:21:17 -07'00'

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United States Department of the Interior

FISH AND WILDLIFE SERVICE
San Francisco Bay-Delta Fish and Wildlife Office
650 Capitol Mall, Suite 8-300
Sacramento, California 95814

In Reply Refer To:
2022-0043398

Dr. Alicia Kirchner
Chief, Planning Division
U.S. Army Corps of Engineers, Sacramento District
1325 J Street
P.O. Box 36152
Sacramento, California 95814-2922

Subject: Reinitiation of formal consultation on the Lower San Joaquin River Feasibility Study, TS-30L Reach, San Joaquin County, California

Dear Ms. Kirchner:

This is in response to the U.S. Army Corps of Engineers' (Corps) letter requesting formal consultation with the U.S. Fish and Wildlife Service (Service) on the Lower San Joaquin River Feasibility Study (LSJRFS), TS-30L Reach (proposed project). At issue are the effects of the proposed project on the federally-listed as threatened giant garter snake (*Thamnophis gigas*) (GGS) and valley elderberry longhorn beetle (*Desmocerus californicus dimorphus*) (VELB). Your letter, with a Supplemental Biological Assessment (SBA) dated May 2023, was received by our staff on May 15, 2023, via file download from a web link which you provided that day in an e-mail. According to the Supplemental Biological Assessment (SBA) included with your request, reinitiation is being pursued for two reasons: (1) changes in the location of VELB mitigation and (2) a design deviation for TS-30L was not approved by the Corps. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act).

A Biological Opinion (BiOp) for the LSJRFS of which the proposed project is part was previously issued on June 13, 2016 (Service File Number 08ESMF00-2015-F-0206). The LSJRFS involves 24 miles of flood control improvements including levee work on Tenmile, Fivemile, Fourteenmile, and French Camp sloughs, the San Joaquin and Lower Calaveras Rivers, Duck Creek and Shima Tract, as well as two closure structures on Fourteenmile Slough and Smith Canal. The level of detail in the project description in this BiOp is limited to what was known at the time it was written, with only a general description of each measure and reaches applicable to the measures. However, Term and Condition 1 of the BiOp outlines a process for further specification of impacts and mitigation, including provision 1(d) which requires that mitigation be complete prior to project impact.

On June 16, 2023, we issued a draft 30-day letter which identified deficiencies in the information provided in your reinitiation request. The most significant deficiency was the sequence of construction impact on listed species habitats prior to mitigation being complete, in contradiction with BiOp Term and Condition 1(d). Other deficiencies concerned clarifying the area of VELB habitat and post-construction GGS habitat. Since that time, the Corps has revised the proposed project to increase impact avoidance, supplement mitigation measures, and reduce but not eliminate the time between construction impact and mitigation completion. Although your revised project is still not in compliance with Term and Condition 1(d), we believe the revision and consideration of changed circumstances, discussed below, warrant that we may proceed with formal consultation in this instance.

A brief revised project description for TS-30L is included in this reinitiation based on comparison of the BiOp with the SBA. As appropriate, we have included special Terms and Conditions specific only to TS-30L, and a Conservation Recommendation that shall apply to subsequent project reaches. For other reaches, Term and Condition 1(d) has been deleted but its content incorporated into the project description at the Corps' request. Other necessary amendments to Terms and Conditions and the project description are made based on changed circumstances since the BiOp was issued (see below, CHANGED CIRCUMSTANCES).

The Corps has twice previously reinitiated under this BiOp for the construction of the Smith Canal Gate element (in 2019 and 2023), within which we updated the project description and impacts, and revised (reduced) the mitigation credits needed for both the Smith Canal Gate and Fourteenmile Slough Gate elements. Smith Canal Gate has been under construction for several years and is being done under a Corps permit by the local sponsor.

CONSULTATION HISTORY

This consultation history identifies key events, communications, documents, and/or new information most relevant to this reinitiation. It is not intended to be exhaustive.

May 15, 2023: Corps transmits letter and SBA requesting reinitiation of formal consultation.

June 16, 2023: Service transmits draft 30 day letter of deficiency.

July 6, 7, and 13, 2023: Three calls are held to discuss deficiencies and additional measures of avoidance and mitigation beyond that described in the SBA. Materials presented at these calls are provided by separate email, with the last used to represent the conservation measures and effects described in this reinitiation (Corps 2023a).

July 18, 2023: Corps staff responds by email to Service questions on the nature and timing of specific activities, construction phasing, and assuring that mitigation will proceed independent of levee construction work (Corps 2023b).

July 19, 2023: Service staff informed the Corps it would proceed with this reinitiation with additional measures and language to ensure compliance with Term and Condition 1 going forward.

August 17, 2023 - October 5, 2023: Multiple calls are held between Service and Corps staff, and multiple drafts of the reinitiation response are exchanged, with emphasis on the project description and Terms and Conditions.

October 5, 2023: Corps and Service staff reach agreement with the latest draft reinitiation response, including the project description.

CHANGED CIRCUMSTANCES

In addition to the reasons stated in your letter, based on the above Consultation History, there are other circumstances that have changed since our BiOp that need to be addressed in this reinitiation, including:

- Design refinements, in late 2020, include a westward levee prism shift and patrol maintenance road that will now require removal of most vegetation on the waterside slope, increasing the effect on listed species habitats.
- VELB guidance was updated in 2017, replacing the former guidance based on bush/stem count with other criteria (USFWS 2017).
- Beginning around late 2019, mitigation bank credits at banks were no longer available.
- Adjacent rice agriculture was identified in 2020, which increases the potential for GGS occupation of project-affected ditch and wetland habitat at TS-30L.
- Additional sites were identified and evaluated in 2022 in the context of providing mitigation in best accordance with Term and Condition 1(d) (i.e., nearest in projected completion time; location; other factors).
- Supplemental FWCA funding was provided in 2021 which allowed the Service to conduct a site visit, provide further guidance, conduct a habitat evaluation, and review prior guidance (USFWS 2016; 2021a,b; 2022).
- Service Mitigation Policy was revised in May 2023, and now includes a separate policy for listed species (Federal Register docket number FWS-HQ-ES-2021-0014).

Planning for the LSJRFS, which included TS-30L, was one of the first in the Nation under the Corps' "3x3x3" or "SMART" planning guidance for feasibility studies (Corps 2015). This had the expected effect of limiting the level of descriptive information available to the Service at the time of first issuance of a BiOP. A reading of the Corps responses to our recommendations in its 2018 final environmental document indicates that it knew then that further specification of impacts and evaluation of mitigation options, involving additional coordination funding and technical assistance, would be required. This was not completed prior to this reinitiation.

We attribute this execution failure to three factors: first, the SMART planning guidance did not consider consultation needs after feasibility concluded. While acknowledging that design detail would be low, subject to revision during PED, and was (p. 15, Corps 2015) "...not intended to be....permit ready...", it discussed the ESA consultation process only during the feasibility phase and not during PED. Second and relatedly, an expectation that impact numbers are approximate and subject to change did not allow a precise matching of mitigation and impact. Absent such a match, in this project and others, the Corps routinely states that it will buy what it needs in the form of conservation bank credits when the precise number is known. But bank credit availability fluctuates, is often in short supply, and not planned in siting or amount to offset the larger impacts of Federal projects. Third, both the SMART planning timeframe and limited focus on purchasing credits has caused mitigation planning to be deprioritized during PED. Instead, the Corps' focus of PED is on completing civil designs first, leaving habitat impact and mitigation planning for later. As a result, civil designs are finalized before mitigation. This not only does not allow for advance mitigation, but it can foreclose opportunities for avoidance and minimization.

In the course of developing this response, it became clear that the Service needs to clarify the meaning of advance mitigation as intended by our revised policy. Mitigation is to be considered in advance when it is functional to the point of providing benefit to the species. In the sense of construction activity, mitigation could be complete or nearly so prior to providing that benefit. The original BiOp did not specify such a period, instead requiring submittals (BiOp p. 33, Term and Condition 1) "...after designs are completed but before commencement of bidding or construction..."

Our understanding of the Corps' bidding process is that it is a 6-9 month process that includes advertisement, award, and submittals, prior to construction. However, portions of the work such as vegetation removal that cause the first impact on habitat could potentially be bid separately in a way that reduces this process to a few months, well in advance of other construction. If done in this manner, vegetation removal could occur days or weeks after mitigation planting is complete, before actual benefit is provided. This was not our intent. We believe the minimum time period for generating a functional benefit to the species is one year which we will recommend be a planning goal, but will not be mandated by a Term and Condition.

To correct the current situation and prevent its recurrence, we have done the following: Term and Condition 1(d) for this project reach only, TS-30L, is replaced with substitute Term and Condition checkpoints to ensure timely completion and performance of mitigation; for all other project reaches, the content of Term and Condition 1(d) is now incorporated into the project description expressly stating that provision of mitigation will precede impacts; additionally, for all other project reaches, the project description now includes language to allow exception to advance mitigation in certain circumstances such as where it is integrated within a project reach, as well as further policy-compliant exceptions with Service agreement; a new Term and Condition is added for an annual update of planning of all construction and mitigation in the next 5 years; and a new Conservation Recommendation is added to provide funding under the Fish and Wildlife Coordination Act from the onset of PED. A Conservation Recommendation is added to recommend, but not require, that mitigation be completed 1 year in advance.

BIOLOGICAL OPINION

Description of the Action

For the purpose of this reinitiation, the project description includes work for both the levee improvement and the mitigation.

Levee Construction

The action covered by this reinitiation is improvement to a 5,900 linear foot section of levee known as TS-30L. TS-30L is the levee section of Tenmile Slough between March Lane and Fourteenmile Slough. For this section, the BiOp project description mentions cutoff-wall, slope reshaping (with landside only geometry correction), and erosion protection[1]. The changes which cause the additional effects that triggered reinitiation concern an additional patrol road and how levee geometry will be corrected. TS-30L is too steep on the landside. For the revised project, the levee prism will be shifted 20 feet to the waterside. Material will be added to the waterside instead of the landside. The levee would be reshaped from 3:1 H:V (Horizontal:Vertical) waterside and 2:1 landside to 2.5:1 and 3:1 H:V, respectively. There also would be patrol roads on the east and west. All these design changes are proposed to avoid impacting residences to the east, but result in increased impact to habitat to the west.

The 2024 levee reconstruction period (Phase 1) is scheduled for September 9 to October 30, 2024. A flood season waiver will be requested in early 2024 as a contingency in case construction activities are not completed prior to the flood season. The waiver may not be granted until closer to the flood season. Activities during Phase 1 would include development of the TS-30L stockpile site; transport of material from the Stockton East Water District borrow site to the TS-30L stockpile site; excavation of the waterside corridor in order to construct the waterside levee key; and construction of that key and patrol road with appropriate material fill.

The 2025 levee reconstruction period (Phase 2) is scheduled to begin in April 2025 and conclude by the end of October 2025. Phase 2 activities include levee degrade, slurry wall installation, levee regrade, reshaping, and rebuilding, rock blanket installation, top of levee road, and other elements. Temporarily disturbed areas will be reseeded.

Conservation Measures

The compensatory mitigation element of the project will be a 41.65 acre site named San Joaquin River West (SJRW), located 1-2 miles southwest of TS-30L. The proposed sequence of this work would start with relocation of the 10 elderberry shrubs to SJRW sometime between January 1 and February 15, 2024. Activities expected prior to mitigation construction would include a 100% design and property acquisition by December 2023. Actual mitigation construction activities will commence in May 2024. Activities scheduled for completion prior to TS-30L vegetation removal include recontouring and wetland construction, seedling and installation of permanent erosion control, and water source and supply line construction. Site planting would start in August 2024 and be complete by August 2025.

On August 14, 2024, protective fencing will be installed around TS-30L project areas to be retained and excluded from vegetation removal. Vegetation removal at TS-30L will occur no sooner than August 15, 2024 and be completed prior to September 9, 2024. If levee reconstruction activities or requisites for these activities such as other permits, land acquisition, rights of entry, or any other factor become delayed, vegetation removal may also be delayed. Removed vegetation will be conserved and re-used to the extent deemed appropriate, as dead

[1] Note: The BiOp included cutoff wall as an original action for TS-30L in Appendix A and Figure 1, but not in the main text (BiOp p. 5, paragraph 1).

wood for brush piles at TS-30L for GGS refugia, or distributed fallen wood or brush piles at SJRW. Whether or not vegetation removal occurs as scheduled, mitigation construction activities would continue uninterrupted at SJRW, including planting row layout and installation of the irrigation system. Planting would be completed by April 2025. The mitigation site will include some raised areas called habitat hills that will function as winter habitat refugia for GGS. An additional 3.7 GGS credits will be purchased for partial loss of winter brumation habitat.

For each discrete LSJRFS phase or construction element other than TS-30L, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction. In some instances, subject to Service agreement, circumstances may require that some elements of compensatory mitigation be implemented concurrent with bidding or construction, in which cases appropriate mitigation would be applied consistent with Corps and Service policy. The term “construction” includes all activities without exception, including any disturbance of habitat (transplantation, removal, limbing up of nesting trees, preceding actual levee work). The term completed separate construction as it applies to compensation sites means completion of earthwork and planting, and does not include maintenance and monitoring periods. Exception: this requirement for advance mitigation shall not apply to reaches where the mitigation is incorporated within that element’s impact area or otherwise dependent on completion of the element, such as replanting of disturbed areas, levee setback areas, or similar circumstances where advance mitigation is physically impossible.

With regard to the preceding paragraph on future reaches, the Corps affirms that its planning goal is to have mitigation complete at least one year prior to impacts, but this goal is not a requirement. As such, the Corps will consider its actions compliant with this Biological Opinion as long as mitigation is physically complete before bidding or construction. The Corps also understands that Service policy as it concerns listed species has been revised and limits policy-compliant mitigation that is not in advance, including concurrent mitigation, to those instances in which advance mitigation is not practicable (p. 9, Endangered Species Act Compensatory Mitigation Policy (Appendix 1, 501 FW 3)(ESA-CMP)(Federal Register docket number FWS-HQ-ES-2021), using the definition of practicable therein (p. 23, ESA-CMP). The Corps will not request a non-Policy compliant exception to advance mitigation, beyond the specific exceptions noted in the preceding paragraph.

Effects of the Action

The following language describing the effects of TS-30L construction on listed species is to be considered an update to our BiOp for this specific element.

Giant Garter Snake

The Service now considers the aquatic ditch and associated upland of TS-30L to be potential GGS habitat based on presence of essential physical and biological features such as permanent water, wetlands, and adjacent rice agriculture, known to support this species. All 2.3 acres of the ditch would be temporarily impacted, and 0.6 acres would be permanently lost. About 8.9 acres of earthen bank, capable of functioning as winter brumation habitat, would be permanently impacted by conversion to riprap. Permanent effects would be offset by brush piles on the impact site, habitat hills at the SJRW site, and purchase of 3.7 GGS credits prior to impact. A portion of the existing upland habitat, about 2 acres, would be conserved and protected from impacts by fencing during construction.

Valley Elderberry Longhorn Beetle

About 11.9 acres of the impact site for TS-30L considered VELB riparian habitat would be permanently impacted, and about 2 acres of that habitat would be conserved and protected from impacts by fencing during construction. It is a mosaic of riparian, wetland, and ditch habitat that, based on our best professional opinion, functions as VELB riparian habitat. These permanent effects would be offset by creation of 41.65 acres of a similar habitat mosaic at SJRW. Additionally, 10 elderberry shrubs would be transplanted from TS-30L to an appropriate location at SJRW.

AMENDMENTS

After review of the SBA, our BiOp for the LSJRFS is amended as follows:

1. For the purpose of construction of TS-30L only, CHANGE Term and Condition 1(d) (BiOp p. 33):

From:

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: ...(d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction;

To:

1. The following submittals shall be required for the construction of the element known as TS-30L:

1(d)(1): No later than December 31, 2023, and prior to the transplantation of elderberry shrubs, the Corps shall submit to the Service proof of completed purchase of the site known as SJRW;

1(d)(2): No later than December 31, 2023, and prior to transplantation of elderberry shrubs, the Corps shall submit to the Service, 100% designs for the site known as SJRW; this submittal shall include a narrative that explains design benefits to listed species. For VELB, the narrative will discuss the extent of consistency of the design with the Service's 2017 Framework guidance document and explaining any deviations from it. For GGS, the narrative will discuss the approximate amounts and presence of essential physical and biological features for this species in the design.

1(d)(3): Vegetation removal within TS-30L shall be conditional on adequate mitigation progress that shows likelihood of completion by the proposed August 2025 conclusion of site planting proposed in the SBA. No later than August 1, 2024, and prior to removal of vegetation from

TS-30L, the Corps shall submit to the Service for approval, a mitigation status report on the site known as SJRW with the following elements:

-construction/earthwork done and remaining - with a projection of completion date;
-availability of all plant and seed materials, with a statement that these substantially meet the needs of the 100% design previously submitted;
-a management and monitoring plan, which includes short-term success criteria and remedial measures during the plant establishment phase; and a commitment from the non-Federal sponsor that it will maintain the site as needed in perpetuity.

The Service shall review this submittal and make a signed finding based on it, within seven (7) calendar days, whether or not the mitigation is likely to be completed by August 2025. If it is, the Service will submit its approval that vegetation removal may commence. If it is unlikely to be complete, we will submit this disapproval and vegetation removal shall be delayed, pending completion of further reinitiation of formal consultation in writing by the Service.

1(d)(4) No later than March 31, 2024, the Corps shall submit proof of purchase of an additional 3.7 GGS credits.

2. For the purpose of construction of elements other than TS-30L, DELETE Term and Condition 1(d) (BiOp p. 33):

Delete 1(d) (in *boldface italics*):

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: ...***(d) documentation of the acquisition of credits or completed separate construction of any required compensation habitat needed to offset the effects of any proposed project construction;***

3. For the purpose of construction of elements other than TS-30L, CHANGE Term and Condition 1(a)(ii) (BiOp p. 33):

From (in *boldface italics*):

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: (a) a pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically... ***(ii) numbers of elderberry shrubs and stems in the diameter classes considered habitat for the beetle in accordance with the Conservation Guidelines...***

To:

1. For each discrete phase or construction contract, after designs are completed but before commencement of bidding or construction, the Corps will submit to the Service: (a) a

pre-construction accounting of the actual amount of listed species habitat which will be temporarily and permanently affected by that phase of the project, specifically... ***(ii) numbers of elderberry shrubs, suitable habitat area deemed riparian (in proximity to or under the influence of an adjacent or nearby water course, natural or manmade) or non-riparian (not meeting above definition of riparian), maximum stem or trunk diameter, and exit hole survey results, all in accordance with the 2017 Framework (the Corps is therefore responsible for planning and conducting those exit hole surveys in an appropriate period preceding this submittal)...***

4. ADD the following Term and Condition:

8. Recurrent mitigation planning summary: By May 1 of each calendar year, beginning in 2024, the Corps shall submit a summary document on listed species habitat impacts and mitigation construction for the next five (5) calendar years. Elements of this status report shall include, for each construction element planned in this period: (a) the construction element name; (b) for each listed species, the estimated area of habitat impact and how this estimate was determined; (c) the estimated date (month/year) of first impact; (d) the estimated area of habitat mitigation and how this estimate was determined; (e) the location(s) of habitat mitigation in at least the amount specified in 8(d); (f) the estimated completion date(s) of mitigation; and (g) expected (or actual, if completed) coordination and technical assistance with the Service on the mitigation determination.

5. ADD the following Conservation Recommendations:

3. In a timely manner, provide the necessary funding for Service participation in supplemental FWCA activities at the outset of PED for each element.

4. Plan to have mitigation complete and fully in place at least 1 year (365 days) prior to the onset of impacts of each discrete phase or construction contract.

REINITIATION—CLOSING STATEMENT

This concludes this reinitiation of formal consultation on the LSJRFS, TS-30L Reach. As provided in 50 CFR §402.16, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained (or is authorized by law) and if: (1) the amount or extent of incidental take is exceeded; (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action. In instances where the amount or extent of incidental take is exceeded, any additional take will not be exempt from the prohibitions of section 9 of the Act, pending reinitiation.

If you have any questions regarding this reinitiation, please contact Steven Schoenberg of my staff at (916) 930-5672 or at Steven_Schoenberg@fws.gov, or Stephanie Millsap at (916) 930-2658 or at Stephanie_Millsap@fws.gov.

Sincerely,

Donald Ratcliff
Field Supervisor

cc:
Dave Fluetsch, Army Corps of Engineers, Sacramento, CA
Lorena Guerrero, Army Corps of Engineers, Sacramento, CA
Lyla Pirkola, National Marine Fisheries Service, Sacramento, CA
Zach Kearns, Region II, California Department of Fish and Wildlife, Sacramento, CA
Larry Ito, Department of Water Resources, Sacramento, CA
Chris Elias, San Joaquin Area Flood Control Agency, Stockton, CA

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

JUN - 7 2016

Refer to NMFS No: WCR-2015-3809

Ms. Alicia Kirchner
Acting Regional Resources Manager
Department of the Army
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Lower San Joaquin River Feasibility Study in the area surrounding the City of Stockton, San Joaquin County.

Dear Ms. Kirchner:

Thank you for your letter of November 6, 2015, and accompanying biological assessment, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Lower San Joaquin River Feasibility Study (Project).

Based on the best available science and commercial information, the Biological Opinion (Opinion) concludes that the Lower San Joaquin River Feasibility Study is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncoryhnchus tshawytscha*), threatened California CV steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened Southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify the designated critical habitats for California CV steelhead or sDPS green sturgeon. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the Project.

This letter also transmits NMFS' essential fish habitat (EFH) conservation recommendations for Pacific salmon as required by the Magnuson-Stevens Fishery Conservation and Management Act (MSA) as amended (16 U.S.C. 1801 *et seq.*).

The EFH consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the BO and includes additional conservation recommendations specific to the adverse effects to Pacific salmon EFH in the action area as described in Amendment 18 of the Pacific Coast Salmon Plan.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the Project on EFH (50 CFR 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Lower San Joaquin River Feasibility Study and the measures needed to avoid, minimize, or mitigate such effects.

Please contact Jeffrey Stuart at the NMFS California Central Valley Office, 916-930-3607, or at J.Stuart@noaa.gov, if you have any questions concerning these consultations, or if you require additional information.

Sincerely,

for William W. Stelle, Jr.
Regional Administrator

cc: Division Chron File: 151422WCR2015SA00098

Ms. Janet Whitlock, U.S. Fish and Wildlife Service, 2800 Cottage Way, Sacramento, CA 95825

Mr. Steven Schoenberg, U.S. Fish and Wildlife Service, 2800 Cottage Way, Sacramento, CA 95825

Mr. Daniel Welsh, Bay-Delta Fish and Wildlife Office, 650 Capitol Mall, Suite 8-300, Sacramento, CA 95814

Ms. Krystal Spur, California Department of Fish and Wildlife, 2109 Arch Airport Road, Suite 100, Stockton, CA 95206

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Consultation

Lower San Joaquin River Feasibility Study

NMFS Consultation Number: 2015-SA00098

Action Agency: U.S. Army Corps of Engineers (Corps)

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species or Critical Habitat?*	Is Action Likely To Jeopardize the Species?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
CV spring-run Chinook salmon (*Oncoryhnchus tshawytscha*)	Threatened	Yes	No	NA
California CV steelhead (*O. mykiss*)	Threatened	Yes	No	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	No

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

for William W. Stelle, Jr.
Regional Administrator

Date: JUN - 7 2016

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into sections 2 and 3 below. The U.S. Army Corps of Engineers (Corps) proposes to implement flood risk management measures under the Lower San Joaquin River Feasibility Study. The purpose of this Biological Opinion (Opinion) is to analyze the potential effects of repairing levees in the greater Stockton metropolitan area and constructing two flood control gate structures on listed threatened and endangered species and on designated critical habitat, within the Project's area of effects (action area) under the Endangered Species Act (ESA).

1.1.1 Background, Authority, and Policy

The National Marine Fisheries Service (NMFS) prepared the Opinion and incidental take statement portions of this document in accordance with section 7(b) of the ESA of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

NMFS also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

NMFS completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). A complete record of this consultation is on file at the NMFS California Central Valley Area Office.

1.1.2 Background

The Corps and its non-Federal sponsors, the San Joaquin Area Flood Control Agency (SJAFCA) and the State of California Central Valley Flood Protection Board (CVFPB), represented by the California Department of Water Resources (DWR), are conducting the Lower San Joaquin River Interim Feasibility Study (LSJRFS or Project hereafter).

The purpose of the LSJRFS is to investigate and determine the extent of Federal interest in a range of alternative plans designed to reduce the risk of flooding in the cities of Stockton, Lathrop, Manteca, and surrounding urbanizing areas. These areas have experienced multiple flooding events since records have been maintained. The existing levee system within the study area protects over 71,000 acres of mixed-use land with a current population estimated at 264,000 residents and an estimated $21 billion in damageable property.

The general authority for flood control investigations in the San Joaquin River Basin arises under the Flood Control Act of 1936 (Public Law [PL] 74-738), sections 2 and 6 and amended by the Flood Control Act of 1938 (PL 75-761). The Flood Control Act of 1936, section 6 permits further reports to be authorized by congressional resolutions. Further studies of this river system were directed in the May 8, 1964, resolution adopted by the Committee on Public Works of the House of Representatives.

The LSJRFS is being accomplished in accordance with the section 905(b) Analysis (Water Resources Development Act (WRDA) 1986) dated September 23, 2004. The section 905(b) Analysis was approved by the Commander, South Pacific Division (SPD) on June 10, 2005. The section 905(b) Analysis was prepared with funds identified in House Report 108- 357 (Conference Report to accompany H.R. 2745 for the Energy and Water Development Appropriations Act of 2004) for use under the Sacramento-San Joaquin River Basins Comprehensive Study (Comprehensive Study) for a reconnaissance study to evaluate environmental restoration, flood protection, and related purposes for the Lower San Joaquin River. House Report 105-190, which accompanied the Energy and Water Development Appropriations Act of 1998 (PL 105-62) authorized the Comprehensive Study.

The section 905(b) Analysis determined that there was Federal interest in pursuing feasibility level investigations for potential flood risk reduction and ecosystem restoration projects in the Lower San Joaquin River area. This study has been focused on flood risk reduction through additional scoping and coordination with the non-Federal sponsors, resource agencies, and local stakeholders and does not include environmental restoration.

This study will only partially address the Comprehensive Study authority. Therefore, the LSJRFS will be called an "Interim Feasibility Report" which indicates that the study is addressing the flood risk issues of a specific area within the authority, rather than the entire area authorized for study.

1.1.3 Authority and Policy

Non-Discretionary Actions

The Corps has indicated in its biological assessment (BA) (Corps 2015) that they have no discretion in regards to the continuing existence and operation of the flood control structures of the Lower San Joaquin River and Tributaries Project (LSJRTP). They assert to have responsibility to ensure Civil Works structures are maintained to appropriate standards such that they continue to serve the congressionally authorized purposes inherent in the authority to construct them and their responsibility to ensure that these structures are maintained, is non-discretionary. The Corps claims that only Congressional actions to de-authorize the structures can alter or terminate this responsibility and thereby allow the maintenance of the structures to cease.

The Corps declares in its BA that it has a non-discretionary duty to maintain the LSJRTP and the fact that the Corps perpetuates the Project's existence is not an action subject to this consultation. The Federal government maintains oversight but has no ownership of, or direct responsibilities for, performing maintenance activities on the Federal levee system, except for the few select features that continue to be owned and operated by the Corps. Considering these exceptions, the great majority of levees, channels, and related flood risk management structures are owned, operated, and maintained by the State of California and local levee and reclamation districts as governed by Corps Operations and Maintenance (O&M) manuals. The 1959 Standard O&M manual for the LSJRTP is the primary O&M manual for this area. There are two supplemental O&M manuals that cover the Project area, the 1963 LSJRTP Unit 1 manual and the Mormon Slough Project manual. The levees of the Project are part of the LSJRTP and therefore covered in the 1959 O&M manual or one of the supplemental O&M manuals.

Discretionary Actions

The Corps has maintained in its BA that it has discretion in the application of construction methodologies and timing of construction activities in relation to discharging its non-discretionary duties to maintain the functionality of the levees within the LSJRTP and provide flood protection. Following completion of construction of the upgrades to the levees comprising the Project, the Corps will prepare a supplement to the 1959 O&M manual which will specify maintenance requirements for these improved levees. Because the Corps does have discretion in how and when levee maintenance activities are performed (as opposed to the results of maintenance which are required to meet certain standards), maintenance activities are discretionary actions that are part of the proposed action subject to consultation.

Typical maintenance activities would include vegetation control through mowing, herbicide application, and/or slope dragging; rodent control; patrol road maintenance; and erosion control and repair. Vegetation control typically would be performed twice a year. Herbicide and bait station application would be conducted under county permit by experts licensed by the state for pest control. Erosion control and slope repair activities would include re-sloping and compacting; fill and repair of damage from rodent burrows would be treated similarly. These activities are performed for approximately 20 days annually. Patrol road reconditioning activities would typically be performed once a year and would include placing, spreading, grading, and compacting aggregate base or substrate.

To meet Federal Flood Control Regulations (33 CFR 208.10) and state requirements (California Water Code section 8370), the Federal Flood Risk Management facilities are inspected four times annually, at intervals not exceeding 90 days. DWR would inspect the system twice a year, and the local maintaining authorities would inspect it twice a year and immediately following major high water events. The findings of these inspections would be reported to the CVFPB's Chief Engineer through DWR's Flood Project Integrity and Inspection Branch.

Each Federal agency has an obligation to insure that any discretionary action it authorizes, funds, or carries out is not likely to jeopardize the continued existence of any endangered or threatened species or destroy or adversely modify its critical habitat. Furthermore, under section 2 of the ESA, it is declared that all Federal agencies shall seek to conserve endangered species and threatened species and shall utilize their authorities in furtherance of the purposes of the ESA. In regards to species and critical habitat compensation, the Corps has the authority to compensate prior to, or concurrent with, project construction impacts. This authority is given under WRDA 1986 (33 USC §§ 2201–2330).

1.2 Consultation History

The Corps has been informally consulting with the U.S. Fish and Wildlife Service (USFWS) and NMFS during the development of the feasibility of the Project. Meetings and phone calls with the Corps and NFMS have taken place to discuss the Project and the potential species affected within the study area. With the completion of the LSJRFS, the Corps has requested formal section 7 consultation with NMFS on this Project prior to receiving authorization for funding. If the Project is authorized and funded, it would move into the Preliminary Engineering Design (PED) phase.

During PED phase, coordination with the resource agencies would continue in order to ensure that the Project remains in compliance with the completed section 7 consultation. The Corps would coordinate potential design refinements with the Services to avoid, minimize, and off-set any adverse effects on listed species. Formal section 7 consultation would be reinitiated with NMFS if changes to the Project occurred that were noncompliant with this Opinion. The following list summarizes the consultation history to date:

- 2013 – Initial species list obtained for the study area of the LSJRFS.
- May 29-30, 2013 – USFWS, DWR, and the Corps environmental staff participated in a field tour of the Project area.
- 2014 – Updated species list obtained.
- On June, 24, 2014, the USFWS submitted a Draft Fish and Wildlife Coordination Act Report to the Corps.
- July 22, 2014 – The Corps, USFWS, and NMFS met to discuss the study status, the Project alternatives, draft impact assessment, and approaches to mitigation and conservation measures.
- February 5, 2015 – an updated species list for San Joaquin County and pertinent quads was obtained from the USFWS website.
- March 2, 2015 – The Corps transmitted the draft BA to NMFS and requested comments prior to initiating section 7 consultation with NMFS under the ESA.
- March 31, 2015 – NMFS sent correspondence to the Corps requesting additional information from the Corps to support the consultation.
- April 2, 2015– The Corps and NMFS met to discuss NMFS' letter advising the Corps of additional information needed to support the consultation.
- July 30, 2015 – The Corps and NMFS biologists had a phone conversation to discuss potential conservation measures for the Project. Discussion centered on potential areas where conservation measures would be most effective.
- September 17, 2015 – Meeting between the Corps and NMFS to discuss the Project and conservation measures for the LSJRFS.
- November 9, 2015 - NMFS receives the final biological assessment (BA)(Corps 2015) for the Project and a request for formal section 7 consultation under the ESA from the Corps for effects to threatened California Central Valley (CCV) steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS) and the threatened southern DPS (sDPS) of the North American green sturgeon (*Acipenser medirostris*), their

designated critical habitats, and Essential Fish Habitat (EFH) described for Pacific Salmon (*Oncorhynchus spp.*) in Amendment 18 of the Pacific Coast Salmon Fishery Management Plan.

- December 10, 2015 - NMFS responds to the Corps that sufficient information has been made available to initiate formal consultation under section 7 of the ESA for the LSJRFS. However, NMFS stated in its letter that it will also include effects to individuals of the threatened Central Valley (CV) spring-run Chinook salmon (*O. tshawytscha*) evolutionary significant unit (ESU) in light of the reintroduction of this run of fish into the waters of the San Joaquin River basin. NMFS indicated that the Corps should expect that an Opinion will be furnished to the Corps on or before March 23, 2016.

1.3 Proposed Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02).

This section describes the Project, which consists of the following two broad elements:

- Construction of structural flood risk management features for levees within the action area;
- Establishment of Engineer Technical Letter (ETL) 1110-2-583 compliant levees.

1.3.1 Overview

The structural measures that comprise the plan, the measures used on each reach of waterway, and the conservation measures included in the Project are described in detail in the Corps' BA (Corps 2015), specifically section 3. The approach to establishing ETL compliant levees is described more broadly in the BA.

The Corps has identified a number of problems associated with the flood risk management system protecting the City of Stockton and surrounding areas. There is a high probability that flows in the lower San Joaquin River, Calaveras River, and the Sacramento-San Joaquin estuary (the Delta) or a seismic event would stress the network of levees protecting Stockton to the point that they could fail. The consequences of such a levee failure would be catastrophic, since the area that would be inundated by flood waters is densely urbanized and the flooding could be up to 18 feet deep. The existing levees that are included in the proposed Project are identified as "Federal" or "Non-Federal" in Figure 1. At the request of the levee owner, and by meeting specific standards, some Non-Federal levees are included in the Corps Rehabilitation and Inspection Program and are eligible for rehabilitation assistance under Public Law (PL) 84-99.

Most levees in the Project area require seepage and slope stability improvements in order to meet the Corps criteria. Some levees require slope reshaping, height improvements, and/or erosion protection. The northern portion of the Project area is vulnerable to flooding from the west (the Delta). Options to improve existing levees immediately adjacent to the City of Stockton to reduce risk from this threat are constrained due to urban development. Therefore, two in water flood control gates are also proposed to help alleviate flood risks. In the southern part of the Project area, a new levee extension is proposed on Duck Creek. The BA analyzed the effects of improving the flood risk management system in the vicinity of the City of Stockton. A summary of the flood safety remediation measures proposed for each Project reach is provided in Table 1 and Figure 2.

1.3.2. Project Features by Area

The main structural measures included in the Project are summarized in Table 1 by area and reach. The locations of the measures are shown in Figure 2. A summary of the lineal extent of each structural measure is shown in Table 2.

1.3.2.1 North Stockton

The North Stockton area includes improvements to the Mosher Slough south levee, Shima Tract east levee, Fivemile Slough/Fourteenmile Slough north levee, Fourteenmile Slough west levee, Tenmile slough east levee, and San Joaquin River east levee. The measures proposed to improve the levees in the North Stockton area include cutoff walls, levee height fixes, erosion protection, seismic (deep soil mixing) fixes, and slope reshaping. In addition, a closure structure would be installed across Fourteenmile Slough, approximately 1,600 feet west of Fivemile Slough. These measures are described in more detail in the BA, specifically section 3 (Corps 2015). The locations of each of the measures are shown on Figure 2.

1.3.2.2 Central Stockton Area

The Central Stockton area includes levee improvements to the Calaveras River, San Joaquin River, Smith Canal, and French Camp Slough. For the Calaveras River, approximately 4.25 miles of the north bank (to approximately El Dorado Street) and approximately 3.3 miles of the south bank (to approximately Pacific Street) would be improved with a combination of cutoff walls, slope reshaping, and levee height fixes. Levee improvements will be made on the San Joaquin River from approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure structure. Additional levee improvements will be made from approximately Channel Point on the San Joaquin River upstream to French Camp Slough, including portions of French Camp Slough upstream of the confluence with the San Joaquin River. The locations of each of these are shown on Figure 2.

In addition to the levee improvements, a closure structure would be installed across the mouth of Smith Canal from the San Joaquin River east levee at Brown's Island to the end of Dad's Point. A floodwall (5 to 10 feet high) would also be constructed on Dad's Point to tie the closure structure into the high ground on the shoreline. The average height of the wall would be 5 to 6 feet as measured from the waterside. The closure structure and floodwall design is described in more detail in section 3.3 of the BA (Corps 2015). The closure structure would be operated to prevent inflow into Smith Canal during high water levels in the Delta and San Joaquin River. This would limit the level and duration of water saturation and reduce the risk of levee damage or failure in Smith Canal upstream of the closure structure.

Finally, a new levee would also be constructed at Duck Creek. This levee would be an extension of the existing French Camp Slough north levee and would extend approximately three-fourths of a mile from French Camp Slough to the rail yard. The new Duck Creek levee would be constructed consistent with the Corps levee construction criteria.

1.3.3 Description of Structural Flood Risk Management Measures

Levees in the Project area require improvements to address seepage, slope stability, overtopping, and erosion concerns that make them vulnerable to floods. The recommended actions are composed of different structural measures that address these vulnerabilities. Overall, the recommended actions for the Project includes: (1) 19.4 miles of seepage cutoff walls; (2) 3.2 miles of geometric improvements consisting of levee slope and crown reshaping to meet Federal standards; (3) 3.5 miles of levee height raises mainly to reestablish the design levee height; (4) 0.5 miles of flood walls/sheet pile walls; (5) 3 miles of seismic improvements; (6) 0.75 miles of new levee; and (7) 5 miles of new erosion protection (a majority of the new protection would be on the landside only; however, existing erosion protection disturbed by construction would be replaced). Note that these features overlap one another and cannot be added up to describe the total lineal extent of the Project. The total amount of horizontal flood features (including closure structures) is approximately 24.5 miles.

These measures would be implemented primarily by fixing levees in place. In addition to levee improvements, the Project includes two in-water closure structures located on Smith Canal and Fourteenmile Slough. Once a levee is modified, regardless of the measure implemented, the levee would meet the Corps levee design criteria. This would include slope reshaping and/or crown widening, where required. The levee crowns are required to have 20 feet minimum width on the San Joaquin River and 12 feet minimum width on all other levees included in the Project. Both landside and waterside slopes would also be established at a 3:1 slope, where possible. If necessary, the existing levee centerline would be shifted landward in order to accommodate levee reshaping and height improvements.

For more details on the potential levee modifications listed above and in Table 1, refer to the Project BA, specifically section 3 (Corps 2015).

In addition to the proposed levee improvement measures, the following measures and policies will apply to all of the levee repair alternatives, and will be addressed during construction:

1. Utility encroachments such as structures, certain vegetation, power poles, pump stations, and levee penetrations (*e.g.*, pipes, conduits, cables) will be brought into compliance with applicable Corps policy or removed depending on type and location. This measure will include the demolition of such features and relocation or reconstruction as appropriate on a case-by-case basis (or retrofit to comply with standards). Utilities replacements will occur via one of two methods: (1) a surface line over the levee prism, or (2) a through-levee line equipped with positive closure devices.

2. Private encroachments shall be removed by the non-federal sponsor or property owner prior to construction.

1.3.4 Schedule and timing of Construction Measures

Seasonal Construction Timing

In general, the Corps has indicated in its BA that construction measures for the Project will occur between the middle of July through the end of October for the San Joaquin River mainstem locations (river mile 37 to Smith Canal area, Channel Point upstream to French Camp Slough). For other rivers, sloughs, and streams, the Corps has indicated that work will occur from the middle of April through the end of October.

Overall Schedule and Project Sequencing

The Corps has described in its BA that construction measures are anticipated to begin in the Central Stockton area in 2018. Construction in that area is expected to last approximately 3 years, concluding in 2020. Construction in North Stockton is estimated to begin in 2021. Construction in this area would last 8 years, ending in 2028. Construction of the full Project would take 10 years. These are estimated schedules because Congress has not yet authorized or appropriated funds for detailed engineering designs or construction plans. Final design and construction schedules may be different.

Annual Work

For Central Stockton the annual average work progress is 3 miles of slurry cutoff wall, two-thirds of a mile of geometric improvements, and a half mile of new levee construction per year. During the 3 year span for the projected work in the Central Stockton area, the closure gate at Smith Canal will be constructed. However, the Corps anticipates that completion of this structure should only take two work seasons to accomplish. For the northern Stockton area, the annual construction work progress averages out to one and a quarter miles of slurry cutoff wall, half a mile of geometric improvements, three-eighths of a mile of seismic remediation, and three-fifth of a mile of rock revetment per year.

1.3.5 Establishment of Corps ETL Compliant Levees

The Corps "Guidelines for Landscape Planting and Vegetation Management at Levees, Floodwalls, Embankment Dams, and Appurtenant Structures," (ETL 1110-2-583) dated April 30, 2014, provides the standards for vegetation on and adjacent to Corps facilities. To be in compliance with this standard, the levee and floodwall and 15 feet landward and waterward of the levee toe or floodwall face, must be maintained free of woody vegetation unless a variance to this requirement is granted by the Corps. A levee or floodwall may be considered for a variance to the ETL standard after in-depth engineering analysis by the Corps has been completed that demonstrates that the levee and/or floodwall is not imperiled by maintaining woody vegetation on or within 15 feet of the levee or floodwall.

In order to construct the structural flood risk management features of the Project, vegetation will need to be removed from at least the upper half of the levee (in conjunction with 50 percent levee elevation degradation to achieve the necessary construction site conditions), and perhaps as much as 50 percent of the remaining waterside levee. Constructing some features, like slope reshaping or height repairs, will also require removal of all vegetation from the landside levee face and the landside easement. Constructing the two closure structures and the floodwall on Dad's Point (at Smith Canal) will require removal of waterside vegetation from the waterside levee toe and waterside construction easement.

During the construction phase, the levees included in the Project will be brought into compliance with the ETL. To accomplish this, the levees will undergo intensive engineering evaluation by the Corps during the Project Engineering and Design (PED) phase to determine their suitability for a variance to the ETL. Based upon the information available at this time, and using their engineering judgment, the Corps estimates that 50 percent of the existing vegetation on the lower waterside slope and within the waterside easement may be allowed to remain, meaning that the levees will have upwards of 75 percent of the waterside vegetation removed from the face of the levee. The Corps further estimates that almost none of the vegetation on the landside levee slope or within the landside easement would be allowed to remain.

1.3.6 Post Construction Operation and Maintenance

Once Project construction is complete, the Project would be turned over to the non-Federal sponsor with an Operations and Maintenance (O&M) manual in accordance with the executed Project partnership agreement for construction. The Project partnership agreement is signed before construction begins. Following construction, the non-Federal sponsor would then be responsible for the continued O&M of the Project consistent with the new and/or amended O&M manuals which are also referred to as Operation, Maintenance, Repair, Replacement and Rehabilitation (OMRR&R) Manuals. The O&M Manuals specify the requirements for operating and maintaining the Project.

The Corps has indicated in their BA that the portion of the O&M manual that has been amended will be shared with the USFWS and NMFS for review and comment prior to being finalized to ensure that the Corps is properly incorporating the terms and conditions of any Biological Opinions. The Corps will continue to coordinate and consult with the USFWS and NMFS to further develop endangered and threatened species avoidance measures for inclusion in the amended O&M manuals.

Typical levee O&M in the Project area includes the following actions:

1. Vegetation maintenance up to four times a year by mowing or applying herbicide.
2. Control of burrowing rodent activity monthly by baiting with pesticide.
3. Slope repair, site-specific and as needed, by re-sloping and compacting.
4. Patrol road reconditioning up to once a year by placing, spreading, grading, and compacting aggregate base or substrate.
5. Visual inspection at least monthly, by driving on the patrol road on the crown and maintenance roads at the base of the levee.

The Corps has proposed the following O&M procedures for the two closure gates included in the Project description. The gates will be open except during routine maintenance, flood events, and high tides. Typically, the gates would be operated (closed) under specific conditions during the rainy season and during times when high tides occur in the area. Generally the rainy season and high tides will be between November 1st and April 30th. Gates will typically only be closed for a few hours to a day for astronomical high tide conditions when tides exceed +8.0 ft (North American Vertical Datum 1988 [NAVD88]). During flood events, the gates may be closed for several days when water elevations exceed +8.0 ft (NAVD88). A more detailed description of the O&M procedures is given in section 3.8.3 of the BA (Corps 2015).

1.3.8 Interrelated and Interdependent Actions

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). In this case, there are no interrelated or interdependent actions for this Project.

1.3.9 Proposed Conservation Actions

The Corps will seek to avoid and minimize construction effects on listed species and their critical habitat to the extent feasible, and will implement on-site, and off-site compensation actions as necessary. The Corps proposed measures are:

1. Implement best management practices (BMPs) to prevent any bentonite slurry mixture from seeping out into the adjacent waterways from levee work sites, and require that any slurry delivery piping system be located on the land side of the levee only.
2. Stockpile construction materials such as portable equipment, vehicles, and supplies, at designated construction staging areas or on designated barges, exclusive of any riparian and wetlands areas.
3. Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a complete containment system.
4. Implement erosion control measure BMPs including Storm Water Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. Install and monitor BMPs for effectiveness, and maintain BMPs throughout construction operations to minimize effects to federally listed fish and their designated critical habitat.
5. Schedule construction to periods when listed terrestrial and aquatic species would least likely to be present in the Project area. If construction needs to extend into the timeframe that species are present, coordinate with the resource agencies.
6. Limit site access to the smallest area possible in order to minimize disturbance.
7. Remove litter, debris, unused materials, equipment, and supplies from the Project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
8. Immediately (within 24 hours) clean up and report any spills of hazardous materials to the resource agencies. Report any such spills, and the success of the cleanup efforts in post-construction compliance reports.

9. Designate a Corps-appointed representative as the point-of-contact for any contractor who might incidentally take a living, or find a dead, injured, or entrapped, threatened or endangered species. Identify this representative to the employees and contractors during an all employee education program conducted by the Corps.
10. Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain flows to keep approach velocity at the pump screens at 0.2 feet per second or less when working in areas that may support delta smelt or juvenile salmonids.

To further avoid and minimize Project effects on listed species and their critical habitat the Corps has proposed the following additional measures during the PED phase and prior to construction:

11. Evaluate the suitability of the levees for an ETL 1110-2-583 vegetation variance. Where suitable, pursue a vegetation variance that would allow woody vegetation to remain on the lower waterside portion of the levee and within the 15 foot wide waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements, floodwall, or closure structures).
12. Develop the information necessary to evaluate the feasibility of establishing shaded riparian area (SRA) and shallow water habitat compensatory mitigation outside of the vegetation-free zone (or within it if a vegetation variance is approved) along the Lower Calaveras River.
13. Minimize vegetation removal to the extent feasible.
14. Minimize, to the extent possible, grubbing and contouring activities.
15. Identify all habitats containing, or with a substantial possibility of containing, listed terrestrial, wetland, and plant species in the potentially affected Project areas. To the extent practicable efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
16. Incorporate sensitive habitat information into project bid specifications.
17. Incorporate requirements for contractors to avoid identified sensitive habitats into project bid specifications.

Compensation Measures

Vegetation losses have been roughly estimated at 9 acres of woodland riparian and approximately 20,000 linear feet (lf) of SRA habitat along the water's edge of the levee (see Table 3). To mitigate for the losses of potential SRA and woodland riparian habitat, the Corps has indicated in their BA that they will purchase shaded-riverine credits and floodplain mosaic wetlands (riparian) credits from Cosumnes Floodplain Mitigation Bank. During the PED phase, Project designs will be refined and specific surveys will be conducted to more accurately quantify losses of habitat and determine appropriate mitigation for those losses.

To mitigate for one acre of permanent open water impact and three acres of temporary open water impact associated with construction of the closure structures on Fourteenmile Slough and Smith Canal, the Corps has stated that they will purchase 2 credits (acres) of floodplain mosaic wetland. The Cosumnes Floodplain Mitigation Bank is approved under the 2008 Compensatory Wetland Mitigation Rule and has the appropriate credits available for the Corps to purchase.

This mitigation bank is located in Sacramento County and has been approved by the Corps, United States Environmental Protection Agency (USEPA), NMFS, and the California Department of Fish and Wildlife (CDFW) to provide SRA habitat credits with a service area that includes the Project area.

Table 1: Actions proposed for the Lower San Joaquin River Feasibility Study.

Waterway	Reach	Proposed Measure
	North Stockton	
Mosher Slough	Thornton Road to UPRR railroad tracks	Cutoff wall
Mosher Slough	Shina Tract to Thornton Road	Cutoff wall Levee height fix (sea level rise)
Shima Tract	Mosher Slough to Fivemile Slough	Cutoff wall Erosion protection (landside)
Fivemile Slough	Shima Tract to Fourteenmile Slough	Cutoff wall Erosion protection (landside)
Fourteenmile Slough	Fivemile Sough to proposed Closure Structure	Seismic Fix Slope Reshaping Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	Approximately 1,500 feet west of Fivemile Slough	Closure Structure
Fourteenmile Slough	Approximately 1,250 feet southeast setback out from proposed closure structure	Seismic fix Levee height fix (sea level rise) Erosion protection (landside)
Fourteenmile Slough	From setback cut south to Tenmile Slough	Seismic fix Adjacent levee slope reshaping Erosion protection (landward)
Tenmile Slough	Fourteenmile Slough to March Lane	Cutoff wall Slope reshaping Erosion protection (waterside)
Tenmile Slough	March Lane to West March Lane/Buckley Cove Way	Seismic fix Slope Reshaping Erosion protection (waterside)
Tenmile Slough/ Buckley Cove Marina/ San Joaquin River	West March Lane/ Buckley Cove Way to Calaveras River	Seismic fix Slope Reshaping
Calaveras River – Right/ North Bank	San Joaquin River to North El Dorado Street	Cutoff wall

	Central Stockton	
Calaveras River – Left/South Bank	San Joaquin River to approximately I-5	Cutoff wall
Calaveras River- Left/South Bank	Approximately I-5 to approximately North Pershing Avenue	Cutoff wall Slope Reshaping
Calaveras River – Left/South Bank	Approximately North Pershing Avenue to approximately El Dorado Street	Cutoff wall
San Joaquin River	From approximately 2,100 feet upstream of the Calaveras River to the proposed Smith Canal Closure Structure	Cutoff wall Levee height fix (sea level rise)
Smith Canal	At the mouth of the canal between Brown's Island and Dad's Point	Closure structure
Smith Canal	Dad's Point from the closure structure to approximately375 feet down Monte Diablo Avenue	Floodwall
San Joaquin River	Railroad Bridge just upstream of the Port of Stockton to Burns Cutoff	Cutoff wall Slope Reshaping
San Joaquin River	Burns Cutoff to French Camp Slough	Cutoff wall
French Camp Slough – Right/North Bank	French Camp slough confluence with the San Joaquin River to approximately 500 feet southwest of I-5[1]	Cutoff wall
Duck Creek	500 feet past I-5 crossing to approximately Odell Avenue	New Levee
Duck Creek	Approximately Odell Avenue to McKinley Avenue	Cutoff wall Levee Reshaping Levee height fix

1) Note that some specific sections of this reach have been repaired by RD 404 and will be excluded from the recommended Project.

Table 2: Summary of structural measures included in the proposed Project plan by length/ or quantity.

Structural Measure	Alternative 7a
Cutoff walls	20.1 miles
Levee Reshaping	6.1 miles
Floodwall	0.2 miles
New Levee	0.75 miles
Erosion Protection (landside)	4.9 miles
Seismic Remediation (about 1.3 miles will include a Setback and partial degrade of the existing level)	3 miles
Closure Structure- Smith Canal	1
Closure Structure Fourteenmile Slough	1

1.4 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). This includes the Project footprint and surrounding areas where covered species could be affected by Project-related impacts. The action area for the Project is shown in Figure 3 and includes: the portion of the San Joaquin River between French Camp Slough and the railroad bridge 0.25 miles south of the Stockton Deep Water Shipping Channel (Stockton DWSC); French Camp Slough from El Dorado Street to the San Joaquin River; the Calaveras River from N. El Dorado Street to the San Joaquin River; portions of the Stockton DWSC between Louis Park and approximately river mile 37 on the San Joaquin River; the west side of Fourteenmile, Tenmile Slough, and Fivemile Slough to Mosher Slough; and the south side of Mosher Slough 0.41 miles beyond N. Eldorado Street up to the railroad tracks.

The action area includes perennial waters of the San Joaquin River extending 200 feet perpendicular from the average summer-fall-shoreline and 1,000 feet downstream from the proposed in-water construction areas. This represents the potential area of turbidity and sedimentation effects based on the reported limits of visible turbidity plumes in the Central Valley along the Sacramento River during similar construction activities.

Central Valley (CV) spring-run Chinook salmon, California Central Valley steelhead (CCV steelhead), and the sDPS of North American green sturgeon have the potential to occur in the action area during the Project's period of construction and long term operations. Sacramento River winter-run Chinook salmon are not likely to occur in the action area and will not be discussed further in this Opinion. Designated critical habitats occur in the action area for CCV steelhead (Delta waters) and the sDPS of North American green sturgeon (Delta waters).

Designated critical habitat for Sacramento River winter-run Chinook salmon and CV spring-run Chinook salmon does not occur in the action area and will not be discussed further in this Opinion.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, Federal agencies must ensure that their actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This Opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of a listed species," which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This Opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR 402.02. Instead, NMFS have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

NMFS use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
- Describe the environmental baseline in the action area.

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[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

- Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
- Reach jeopardy and adverse modification conclusions.
- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This Opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential physical and biological features that help to form that conservation value.

The designation of critical habitat for certain ESUs and DPSs used the term primary constituent element or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified primary constituent elements, physical or biological features, or essential features. In this Opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The descriptions of the status of species and conditions of the designated critical habitats in this BO are a synopsis of the detailed information available on NMFS' West Coast Regional website. The following federally listed species ESUs or DPSs and designated critical habitat occur in the action area and may be affected by the proposed action.

CV spring-run Chinook salmon ESU (*O. tshawytscha*)
Listed as threatened (70 FR 37160, June 28, 2005)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/central_valley_spring_run/central_valley_spring_run_chinook.html

CCV steelhead DPS (*O. mykiss*)
Listed as threatened (71 FR 834, January 5, 2006)

CCV steelhead designated critical habitat
(70 FR 52488, September 2, 2005)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/california_central_valley/california_central_valley_steelhead.html

Southern DPS of North American green sturgeon (*Acipenser medirostris*)
Listed as threatened (71 FR 17757, April 7, 2006)

Southern DPS of North American green sturgeon designated critical habitat
(74 FR 52300, October 9, 2009)

http://www.westcoast.fisheries.noaa.gov/protected_species/green_sturgeon/green_sturgeon_pg.html

Critical habitat designations identify those physical and biological features of the habitat that are essential to the conservation of the species and that may require special management consideration or protection. Within the LSJRFS action area this includes the river water, river bottom, and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488).

In 2016, NMFS completed a status review of 28 species of Pacific salmon, steelhead and eulachon, including CV spring-run Chinook salmon, and CCV steelhead, and concluded that the species' status should remain as previously listed (102 FR 33468; May 26, 2016). The 2016 status reviews for CV spring-run and CCV steelhead found that, although the listings should remain unchanged, the status of these populations have suffered in 2014 and 2016 from the unprecedented California drought. An updated status review for sDPS green sturgeon was issued recently (July 2015, NMFS 2015), concluding that the status of sDPS green sturgeon should remain as threatened.

2.2.1 Central Valley Spring-run Chinook salmon

Listing and Distribution

CV spring-run Chinook salmon were originally listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent CV spring-run Chinook salmon listing decision (70 FR 37160, June 28, 2005). Although FRFH spring-run Chinook salmon production is included in the ESU, these fish do not have a section 9 take prohibition under the ESA. The action area is not included in the area designated as critical habitat for the CV spring-run ESU and will not be discussed further in this Opinion. In addition to the potential natural population of CV spring-run in the Sacramento River basin described above, attempts to reintroduce an experimental population to the San Joaquin River basin is underway. A final rule was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the San Joaquin River Restoration Project (SJRRP) (78 FR 251; December 31, 2013). Pursuant to ESA section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. However, the rule includes proposed protective regulations under ESA section 4(d) that would provide specific exceptions to prohibitions under ESA section 9 for taking CV spring-run Chinook salmon within the experimental population area (San Joaquin River from Friant Dam downstream to the confluence of the Merced River), and in specific instances elsewhere. The first release of CV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April 2014. A second release occurred in 2015, and future releases are planned to continue annually during the spring. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined, but is likely to include individuals present in the Project action area in future years.

Historically, spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet elevation) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). Of the 18 to 19 original independent populations existing in four distinct geographic areas in the Central Valley (*i.e.*, diversity groups), only 3 extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the Northern Sierra Nevada diversity group (Lindley et al. 2004). All other independent populations and diversity groups have been extirpated. The Northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the Northern Sierra Nevada diversity group populations for their continued existence (see Figure 4).

Construction of dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, was thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may still persist in the Stanislaus and Tuolumne rivers (Franks, personal communication, 2012), as well as in the Yuba River. Documented naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

Life History

Adult CV spring-run Chinook salmon leave the ocean to begin their upstream migration in late January and early February (CDFG 1998) and enter the Sacramento River beginning in March (Yoshiyama 1998). Spring-run Chinook salmon move into tributaries of the Sacramento River (*e.g.* Butte, Mill, Deer creeks) beginning as early as February in Butte Creek and typically mid-March in Mill and Deer creeks (Lindley *et al.* 2004). Adult migration peaks around mid-April in Butte Creek, and mid-to end of May in Mill and Deer creeks, and is complete by the end of July in all three tributaries (Lindley *et al.* 2004) (Table 4). Typically, spring-run Chinook salmon utilize mid- to high-elevation streams that provide appropriate temperatures and sufficient flow, cover, and pool depth to allow over-summering while conserving energy and allowing their gonadal tissue to mature (Yoshiyama et al. 1998). Spring-run Chinook salmon spawning occurs between September and October (Moyle 2002). Between 56 and 87 percent of adult spring-run Chinook salmon that enter the Sacramento River basin to spawn are 3 years old (Calkins et al. 1940, Fisher 1994). It is expected that the progeny of the experimental population reintroduced to the San Joaquin River basin will have timing that is similar to the timing characteristics of their parental stock from the Sacramento Basin.

Spawning Chinook salmon require clean, loose gravel in swift, relatively shallow riffles or along the margins of deeper runs, and suitable water temperatures, depths, and velocities for redd construction and adequate oxygenation of incubating eggs. Chinook salmon spawning typically occurs in gravel beds that are located at the tails of holding pools (USFWS 1995a). The range of water depths and velocities in spawning beds that Chinook salmon find acceptable is very broad. The upper preferred water temperature for spawning Chinook salmon is 55°F to 57°F (Chambers 1956, Smith 1973, Bjornn and Reiser 1991, and Snider 2001).

Incubating eggs are vulnerable to adverse effects from floods, siltation, desiccation, disease, predation, poor gravel percolation, and poor water quality. Studies of Chinook salmon egg survival to hatching conducted by Shelton (1995) indicated 87 percent of fry emerged successfully from large gravel with adequate subgravel flow. A significant reduction in egg viability occurs at water temperatures above 57.5°F and total embryo mortality can occur at temperatures above 62°F (NMFS 1997). Within the appropriate water temperature range for embryo incubation, embryos hatch in 40 to 60 days, and the alevins (yolk-sac fry) remain in the gravel for an additional 4 to 6 weeks before emerging from the gravel. Fry typically range from 25 mm to 40 mm during this stage.

The post-emergent fry disperse to the margins of their natal stream, seeking out shallow waters with slower currents, finer sediments, and bank cover such as overhanging and submerged vegetation, root wads, and fallen woody debris, and begin feeding on zooplankton, small insects, and small aquatic invertebrates (Healey 1991). Spring-run Chinook salmon fry emerge from the gravel from November to March (Moyle 2002) and the emigration timing is highly variable, as they may migrate downstream as young-of-the- year or as juveniles or yearlings. The modal size of fry migrants are approximately 40 millimeters (mm) between December and April in Mill, Butte, and Deer creeks reflects a prolonged emergence of fry from the gravel (Lindley et al. 2004).

When juvenile Chinook salmon reach a length of 50 mm to 57 mm, they move into deeper water with higher current velocities, but still seek shelter and velocity refugia to minimize energy expenditures. In the mainstems of larger rivers, juveniles tend to migrate along the channel margins and avoid the elevated water velocities found in the thalweg of the channel.

When the channel of the river is greater than 9 feet to 10 feet in depth, juvenile salmon tend to inhabit the surface waters (Healey 1982). Migrational cues, such as increasing turbidity from runoff, increased flows, changes in day length, or intraspecific competition from other fish in their natal streams may spur outmigration of juveniles when they have reached the appropriate stage of maturation (Kjelson *et al.* 1982, Brandes and McLain 2001).

Studies in Butte Creek, (Ward et al. 2003, McReynolds et al. 2007) found the majority of CV spring-run Chinook salmon migrants to be fry, which occurred primarily during December, January, and February; and that these movements appeared to be influenced by increased flow. Small numbers of CV spring-run Chinook salmon were observed to remain in Butte Creek to rear and migrated later in the spring. Juvenile emigration patterns in Mill and Deer creeks are very similar to patterns observed in Butte Creek, with the exception that Mill and Deer creek juveniles typically exhibit a later young-of-the-year migration and an earlier yearling migration (Lindley et al. 2004). CDFW (CDFG 1998) observed the emigration period for spring-run Chinook salmon extending from November to early May, with up to 69 percent of the young-of-the-year fish outmigrating through the lower Sacramento River and Delta during this period. Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December, and again in March and April. However, juveniles also are observed between November and the end of May (Snider and Titus 2000).

Fry and parr may rear within riverine or estuarine habitats of the Sacramento River, the Delta, and their tributaries. Within the Delta, juvenile Chinook salmon forage in shallow areas with protective cover, such as intertidal and subtidal mudflats, marshes, channels, and sloughs (McDonald 1960, Dunford 1975). Cladocerans, copepods, amphipods, and larvae of diptera, as well as small arachnids and ants are common prey items (Kjelson *et al.* 1982, Sommer *et al.* 2001, MacFarlane and Norton 2002). Within the estuarine habitat, juvenile Chinook salmon movements are dictated by the tidal cycles, following the rising tide into shallow water habitats from the deeper main channels, and returning to the main channels when the tide recedes (Levy and Northcote 1982, Levings 1982, Levings *et al.* 1986, Healey 1991).

Once in the ocean, juvenile Chinook salmon tend to stay along the California Coast. This is likely due to the high productivity caused by the upwelling of the California Current. These food-rich waters are important to ocean survival, as indicated by a decline in survival during years when the current does not flow as strongly and upwelling decreases (Moyle 2002, Lindley *et al.* 2009). After entering the ocean, juveniles become voracious predators on small fish and crustaceans, and invertebrates such as crab larvae and amphipods. As they grow larger, fish increasingly dominate their diet. They typically feed on whatever pelagic zooplankton is most abundant, usually herring, anchovies, juvenile rockfish, and sardines. The Ocean stage of the Chinook life cycle lasts one to five years.

Table 4. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River basin[a],[b]												
Sac. River Mainstemb,[c]												
Mill Creek[d]												
Deer Creek[d]												
Butte Creekd,[g]												
(b) Adult Holding[a,b]												
(c) Adult Spawning[a,b,c]												

(d) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sac. River Tribs[e]												
Upper Butte Creekf,[g]												
Mill, Deer, Butte Creeks[d,g]												
Sac. River at RBDD[c]												
Sac. River at KL[h]												

Relative Abundance: = High = Medium = Low

Sources: [a]Yoshiyama et al. (1998); [b]Moyle (2002); [c]Myers et al. (1998); [d]Lindley et al. (2004); [e]CDFG (1998); [f]McReynolds et al. (2007); [g]Ward et al. (2003); [h]Snider and Titus (2000)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Summary of ESU Viability

Since the independent populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on Viable Salmonid Population (VSP) parameters in these watersheds. Lindley *et al.* (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the "representation and redundancy rule" since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the 2011 status review of the CV spring-run Chinook salmon ESU, the authors concluded that the ESU status had likely deteriorated on balance since the 2005 status review and the Lindley *et al.* (2007) assessment, with two of the three extant independent populations (Deer and Mill creeks) of spring-run Chinook salmon slipping from low or moderate extinction risk to high extinction risk. Additionally, Butte Creek remained at low risk, although it was on the verge of moving towards high risk, due to the rate of population decline. In contrast, spring-run Chinook salmon in Battle and Clear creeks had increased in abundance since 1998, reaching levels of abundance that place these populations at moderate extinction risk. Both of these populations have likely increased at least in part due to extensive habitat restoration. The Southwest Fisheries Science Center concluded in their viability report (Williams *et al.* 2011) that the status of CV spring-run Chinook salmon ESU has probably deteriorated since the 2005 status review and that its extinction risk has increased. The degradation in status of the three formerly low- or moderate-risk independent populations is cause for concern.

In the 2016 status review, the authors found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which has moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek has remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations have continued to show stable or increasing numbers the last five years, putting them at moderate risk of extinction based on abundance. Overall, the SWFSC concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased, however the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (Williams et al. 2016).

The 2015 adult CV spring-run Chinook salmon returns were very low. Those that did return experienced high pre-spawn mortality. Juvenile survival during the 2012 to 2015 drought has likely been impacted, and will be fully realized over the next several years.

Critical Habitat and Physical and Biological Features for CV spring-run Chinook salmon

Designated critical habitat for CV spring-run Chinook salmon does not occur in the action area for this Project. It will not be discussed further in this Opinion.

2.2.2 California Central Valley Steelhead

CCV steelhead were originally listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, NMFS reaffirmed its status as threatened and also listed the Feather River Hatchery and Coleman National Fish Hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs and DPSs, NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological, and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). On August 15, 2011, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2011b). Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488).

Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta (Figure 5). Currently the CCV steelhead DPS and critical habitat extends up the San Joaquin River to the confluence with the Merced River. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. Critical habitat for CCV steelhead is defined as specific areas that contain the PBFs and physical habitat elements essential to the conservation of the species. The PBFs for CCV steelhead include freshwater spawning habitat, freshwater rearing habitat, freshwater migration corridors, and estuarine areas. Within the action area, critical habitat PBFs that are present are freshwater rearing areas, freshwater migratory corridors, and estuarine areas. Although highly degraded from decades of human alterations, juvenile and adult life stages are dependent on the function of these PBFs for successful survival and recruitment and therefore even in degraded areas, these PBFs have a high conservation value.

Life History

Steelhead in the CV historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning. Between 1944 and 1947, annual counts of summer-run steelhead passing through the Old Folsom Dam fish ladder during May, June, and July ranged from 400 to 1,246 fish (Gerstung 1971). After 1950, when the fish ladder at Old Folsom Dam was destroyed by flood flows, summer-run steelhead were no longer able to access their historic spawning areas, and either perished in the warm water downstream of Old Folsom Dam or hybridized with winter-run steelhead. Only winter-run (ocean maturing) steelhead currently are found in California CV rivers and streams (Moyle 2002; McEwan and Jackson 1996). Summer-run steelhead have been extirpated due to a lack of access to suitable holding and staging habitat, such as coldwater pools in the headwaters of CV streams, presently located upstream of impassible dams (Lindley et al. 2006).

CV steelhead generally leave the ocean from August through April (Busby *et al.* 1996), and spawn from December through April with peaks from January though March in small streams and tributaries where cool, well oxygenated water is available year-round (Hallock *et al.* 1961, McEwan and Jackson 1996; see Table 5 in text). Timing of upstream migration is correlated with higher flow events, such as freshets or sand bar breaches at river mouths, and associated lower water temperatures. Unlike Pacific salmon, steelhead are iteroparous, or capable of spawning more than once before death (Barnhart *et al.* 1986, Busby *et al.* 1996). However, it is rare for steelhead to spawn more than twice before dying; most that do so are females (Busby *et al.* 1996). Iteroparity is more common among southern steelhead populations than northern populations (Busby *et al.* 1996). Although one-time spawners are the great majority, Shapovalov and Taft (1954) reported that repeat spawners are relatively numerous (17.2 percent) in California streams. Post-spawning steelhead (kelts) may migrate downstream to the ocean immediately after spawning, or they may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954). Recent studies have shown that kelts may remain in freshwater for an entire year after spawning (Teo *et al.* 2011), but that most return to the ocean (Null *et al.* 2013).

The length of time it takes for eggs to hatch depends mostly on water temperature. Hatching of steelhead eggs in hatcheries takes about 30 days at 51°F. Fry emerge from the gravel usually about 4 to 6 weeks after hatching, but factors such as redd depth, gravel size, siltation, and temperature can speed or retard this time (Shapovalov and Taft 1954). Newly emerged fry move to the shallow, protected areas associated with the stream margin (McEwan and Jackson 1996) and they soon move to other areas of the stream and establish feeding locations, which they defend (Shapovalov and Taft 1954).

Table 5. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1]Sacramento R. at Fremont Weir												
[2]Sacramento R. at RBDD												
[3]Mill & Deer Creeks												
[4]Mill Creek at Clough Dam												
[5]San Joaquin River												

(b) Juvenile migration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
[1,2]Sacramento R. near Fremont Weir												
[6]Sacramento R. at Knights Landing												
[7]Mill & Deer Creeks (silvery parr/smolts)												
[7]Mill & Deer Creeks (fry/parr)												
[8]Chipps Island (clipped)												
[8]ChippsIsland (unclipped)												
[9]San Joaquin R. at Mossdale												
[10]Mokelumne R. (silvery parr/smolts)												
[10]Mokelumne R. (fry/parr)												
[11]Stanislaus R. at Caswell												
[12]Sacramento R. at Hood												

Relative Abundance: ■ = High ■ = Medium □ = Low

Sources: [1](Hallock 1957); [2](McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson and Merrick 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by FishBio) summarized by John Hannon (Reclamation) ; [12](Schaffter 1980).

Juvenile steelhead emigrate episodically from natal streams during fall, winter, and spring high flows, when juveniles have undergone a physiological transformation (smoltification) to survive in the ocean, and become slender in shape, bright silvery in coloration, with no visible parr marks. Emigrating Central Valley steelhead use the lower reaches of the Sacramento River, San Joaquin River, and the Delta for rearing and as a migration corridor to the ocean. Juvenile Central Valley steelhead feed mostly on drifting aquatic organisms and terrestrial insects and will also take active bottom invertebrates (Moyle 2002).

Unlike Pacific salmon, steelhead do not appear to form schools in the ocean (Behnke 1992). Steelhead in the southern part of their range appear to migrate close to the continental shelf, while more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1986).

Summary of ESU Viability

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of naturally spawned fish to hatchery produced fish over the past 25 years (Good *et al.* 2005, NMFS 2011b); the long-term abundance trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts captured in monitoring studies has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild CCV steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV steelhead populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011b). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The 2011 status review of the CCV steelhead DPS (NMFS 2011b) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction.

The 2016 status review concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration and dam removal efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

<u>Critical Habitat and Physical and Biological Features for CCV steelhead</u>

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain and Stevenson 1999; 70 FR 52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PBFs and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PBFs for CCV steelhead. PBFs for CCV steelhead include:

1. <u>Freshwater Spawning Habitat</u>

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging woody material, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PCE. Natural cover such as submerged and overhanging woody material, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

2.2.3 Southern DPS of North American Green Sturgeon

Listing and Distribution

In June of 2001, NMFS received a petition to list green sturgeon under the ESA and to designate critical habitat. After completion of a status review (Adams *et al.* 2002), NMFS found that the species was comprised of two DPS's that qualify as species under the ESA, but that neither DPS warranted listing. In April of 2005, NMFS (2005) revised its "not warranted" decision and proposed to list the sDPS of North American green sturgeon as "threatened" in response to a court order that challenged the original determination. In its 2006 final decision to list sDPS North American green sturgeon (also referred to as sDPS green sturgeon in this document) as threatened, NMFS cited concentration of the only known spawning population into a single river (Sacramento River), loss of historical spawning habitat, mounting threats with regard to maintenance of habitat quality and quantity in the Delta and Sacramento River, and an indication of declining abundance based upon salvage data at the State and Federal salvage facilities (71 FR 17757). Since the original 2006 listing decision, new information has become available that reinforces the original reasons for listing and reaffirms NMFS concerns that sDPS green sturgeon face substantial threats, challenging their recovery. Critical habitat was designated for the Southern DPS of North American green sturgeon on October 9, 2009 (74 FR 52300). A new five-year review of the species was issued in August 2015 (NMFS 2015), and finds that the sDPS of North American green sturgeon should remain listed as threatened under the ESA and that many of the listing factors remain unchanged since the initial listing.

Green sturgeon (*Acipenser medirostris*) are broken into two distinct population segments (DPSs), a northern DPS (nDPS) and a southern DPS (sDPS), and while individuals from the two DPS's are visually indistinguishable and have significant geographical overlap, current information indicates that they do not interbreed, nor do they utilize the spawning areas of each other's natal rivers. The sDPS of North American green sturgeon presently contains only a single spawning population within the Sacramento River basin, primarily in the main stem Sacramento River below Keswick Dam but spawning has been documented to occur in the Feather River below Oroville Dam and potentially in the Yuba River where adults exhibiting spawning behavior have been observed. Adults and juveniles occur within the Delta and both life history stages may occur within the action area at any time of the year. Designated critical habitat includes the waters of the legal Delta which includes portions of the action area (mainstem San Joaquin River and portions of Fourteenmile Slough and French Camp Slough). Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. Critical habitat for sDPS of green sturgeon is defined as specific areas that contain the PBFs essential to the conservation of the species, and have been designated in freshwater riverine systems, estuarine habitats, and nearshore marine coastal areas along the west coast of the United States. Only the freshwater riverine systems and estuarine habitats occur in the action area. The PBFs for sDPS green sturgeon in riverine systems include food resources, substrate type or size, water flow, water quality, migratory corridors, water depth, and sediment quality. Within estuarine habitats the PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality. Although highly degraded from decades of human alterations, juvenile and adult life stages are dependent on the function of these PBFs for successful survival and recruitment and therefore even in degraded areas, these PBFs have a high conservation value.

Life History

Green sturgeon are long lived, iteroperous, anadromous fish. hey may live up to 60-70 years; green sturgeon captured in Oregon have been age-estimated using a fin-spine analysis up to 52 years (Farr and Kern 2005). The green sturgeon sDPS includes those that spawn south of the Eel River. Until recently, it was believed that the green sturgeon sDPS was composed of a single spawning population on the Sacramento River. However, recent research conducted by DWR has revealed spawning activity in the Feather River (Seesholtz *et al.* 2015). Additionally, there is some evidence that spawning in the Yuba River may occur based on observed congregations and behavior of adult fish downstream of Daguerre Point Dam (Cramer Fish Sciences 2013), but no physical evidence of successful spawning or fertilized eggs has been recovered to date.

Green sturgeon eggs are adhesive and are broadcast spawned in rivers, typically over hard rocky substrates, but can include cobbles, grave and sand. Green sturgeon larvae hatch from fertilized eggs after approximately 169 hours at a water temperature of 15° C (59° F) (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Studies conducted at the University of California, Davis by Van Eenennaam *et al.* (2005) using nDPS juveniles indicated that an optimum range of water temperature for egg development ranged between 14° C (57.2° F) and 17° C (62.6° F). Temperatures above or below this range resulted in substantially elevated mortalities and an increased occurrence of morphological abnormalities in those eggs that did hatch (Van Eenennaam *et al.* 2005).

Larval green sturgeon hatch in the late spring or summer (peak in July). Newly hatched green sturgeon are approximately 12.5mm to 14.5 mm (0.5 to 0.57 inches) in length and have a large ovoid yolk sac that supplies nutritional energy until exogenous feeding occurs. These yolksac larvae are less developed in their morphology than older juveniles and external morphology resembles a "tadpole" with a continuous fin fold on both the dorsal and ventral sides of the caudal trunk. The eyes are well developed with differentiated lenses and pigmentation. Olfactory and auditory vesicles are present while the mouth and respiratory structures are only shallow clefts on the head. At 10 days of age, the yolk sac has become greatly reduced in size and the larvae initiates exogenous feeding through a functional mouth. The fin folds have become more developed and formation of fin rays begins to occur in all fin tissues. By 45 days of age, the green sturgeon larvae have completed their metamorphosis, which is characterized by the development of dorsal, lateral, and ventral scutes, elongation of the barbels, rostrum, and caudal peduncle, reabsorption of the caudal and ventral fin folds, and the development of fin rays. The juvenile fish resembles the adult form, including the dark olive coloring, with a dark mid-ventral stripe (Deng *et al.* 2002) and are approximately 75 mm (2.95 inches) in length. At this stage of development, the fish are considered juveniles and are no longer larvae.

Young green sturgeon appear to rear for the first one to two months in the Sacramento River between Keswick Dam and Hamilton City (CDFG 2002). Juvenile green sturgeon first appear in USFWS sampling efforts at RBDD in June and July at lengths ranging from 24 to 31 mm fork length, indicating they are approximately two weeks old (CDFG 2002, USFWS 2002). Growth is rapid as juveniles can reach up to 300 mm the first year and over 600 mm in the first 2 to 3 years (Nakamoto *et al.* 1995). Juvenile green sturgeon have been salvaged at the Federal and State pumping facilities (which are located in the southern region of the Delta), and sampled in trawling studies by the CDFW during all months of the year (CDFG 2002). The majority of these fish that were captured in the Delta were between 200 and 500 mm indicating they were from 1+ to 3 years of age, based on Klamath River age distribution work by Nakamoto *et al.* (1995). The lack of a significant proportion of juveniles smaller than approximately 200 mm in Delta captures indicates juvenile sDPS green sturgeon likely hold in the mainstem Sacramento River for up to 10 months, as suggested by Kynard *et al.* (2005). Both nDPS and sDPS green sturgeon juveniles tested under laboratory conditions, with either full or reduced rations, had optimal bioenergetic performance (*i.e.,* growth, food conversion, swimming ability) between 15° C (59° and 19° C (66.2° F), thus providing a temperature related habitat target for conservation of this rare species (Mayfield and Cech 2004). This temperature range overlaps the egg incubation temperature range for peak hatching success previously discussed.

Radtke (1966) inspected the stomach contents of juvenile green sturgeon in the Delta and found food items to include a mysid shrimp (*Neomysis awatschensis)*, amphipods (*Corophium* spp.*)*, and other unidentified shrimp. No additional information is available regarding the diet of sDPS green sturgeon in the wild, but they are presumed to be generalist, opportunistic benthic feeders.

There is a fair amount of variability (1.5 to 4 years) in the estimates of the time spent by juvenile green sturgeon in freshwater before making their first migration to sea. Nakamoto *et al.* (1995) found that nDPS green sturgeon on the Klamath River migrated to sea, on average, by age three and no later than by age four. Moyle (2002) suggests juveniles migrate out to sea before the end of their second year, and perhaps as yearlings. Laboratory experiments indicate that both nDPS and sDPS green sturgeon juveniles may occupy fresh to brackish water at any age, but they are physiologically able to completely transition to saltwater at around 1.5 years in age (Allen and Cech 2007). In studying nDPS green sturgeon on the Klamath River, Allen *et al.* (2009) devised a technique to estimate the timing of transition from fresh water to brackish water to seawater by taking a bone sample from the leading edge of the pectoral fin and analyzing the ratios of strontium and barium to calcium. The results of this study indicate that green sturgeon move from freshwater to brackish water (such as the estuary) at ages 0.5 to 1.5 years and then move into seawater at ages 2.5 to 3.5 years. Table 6 shows the migration timing of various life stages throughout the CV, Delta, San Francisco Bay, and into the Pacific Ocean.

In the summer months, multiple rivers and estuaries throughout the sDPS range are visited by dense aggregations of green sturgeon (Moser and Lindley 2007, Lindley *et al.* 2011). Capture of green sturgeon as well as tag detections in tagging studies have shown that green sturgeon are present in San Pablo Bay and San Francisco Bay in all months of the year (Kelly *et al.* 2007, Heublein *et al.* 2009, Lindley *et al.* 2011). An increasing amount of information is becoming available regarding green sturgeon habitat use in estuaries and coastal ocean habitats along the Pacific coast of North America, and why they aggregate episodically (Lindley *et al.* 2008, Lindley *et al.* 2011). Genetic studies on green sturgeon stocks indicate that almost all of the green sturgeon in the San Francisco Bay ecosystem belong to the sDPS (Israel and Klimley 2008).

Green sturgeon do not mature until they are at least 15 to 17 years of age (Beamesderfer *et al.* 2007). Therefore, it would not be expected that a green sturgeon returning to freshwater would be younger than this. However, once mature, green sturgeon appear to make spawning runs once every few years. Erickson and Hightower (2007) found that nDPS green sturgeon returned to the Rogue River 2 to 4 years after leaving it on their prior spawning run; it is presumed that sDPS green sturgeon display similar behavior and return to the Sacramento River or Feather River system to spawn every 2 to 5 years. Adult sDPS green sturgeon begin their upstream spawning migrations into freshwater as early as late February with spawning occurring between March and July (CDFG 2002, Heublein 2006, Heublein *et al.* 2009, Vogel 2008). Peak spawning is believed to occur between April and June in deep, turbulent, mainstem channels over large cobble and rocky substrates featuring crevices and interstices (Van Eenennaam *et al.* 2001). Poytress *et al.* (2012) conducted spawning site and larval sampling in the upper Sacramento River from 2008 to 2012 and has identified a number of confirmed spawning locations (Figure 6). Green sturgeon fecundity is approximately 50,000 to 80,000 eggs per adult female (Van Eenennaam *et al.* 2001). They have the largest egg size of any sturgeon species. The chorion of the eggs are adhesive, and are denser than those of white sturgeon (Kynard *et al.* 2005, Van Eenennaam *et al.* 2009).

Post spawning, green sturgeon may exhibit a variety of behaviors. Ultimately they will return to the ocean, but the timing and the behaviors exhibited are variable. Illustrating the spectrum of behavioral choices, Benson *et al.* (2007) conducted a study in which 49 nDPS green sturgeon were tagged with radio and/or sonic telemetry tags and tracked manually or with receiver arrays from 2002 to 2004. Tagged individuals exhibited four movement patterns: upstream spawning migration, spring outmigration to the ocean, or summer holding, and outmigration after summer holding.

Table 6. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the CV of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL old for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c,i]												
SF Bay Estuary[d,h,i]												
(b) Larval and juvenile (≤10 months old)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e]												
GCID, Sac River[e]												
(c) Older Juvenile (> 10 months old and ≤3 years old)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta[*f]												
Sac-SJ Delta[f]												
Sac-SJ Delta[e]												
Suisun Bay[e]												
(d) Sub-Adult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]												

Relative Abundance: = High = Medium = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al.* (1992); [c]Adams *et al.* (2002) and NMFS (2005); [d]Kelly *et al.* (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al.* (1995); [h]Heublein (2006); [i]CDFG Draft Sturgeon Report Cards (2011-2015)

Summary of DPS Viability

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany *et al.* 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long term (~100 year) time horizon; therefore the sDPS is not believed to be viable. To support this statement, the population viability analysis (PVA) that was done for sDPS green sturgeon in relation to stranding events (Thomas *et al.* 2013) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley *et al.* (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010) and in the most recent 5-year review (NMFS 2015) the listing under the ESA remains unchanged as threatened, as many of the threats cited in the original listing still exist.

Critical Habitat and Physical and Biological Features for sDPS Green Sturgeon

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR 226.219. Critical habitat (see Figure 7) includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

Critical habitat for sDPS green sturgeon includes principal biological or physical constituent elements within the defined area that are essential to the conservation of the species. PBFs for sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the California Central Valley, NMFS will limit our discussion to freshwater riverine systems and estuarine habitats contained in the Project's action area.

Freshwater Riverine Systems

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel and Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

2. Substrate Type or Size

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, larval development, subadults, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991, Moyle *et al.* 1995). Eggs are likely to adhere to substrates, or settle into crevices between substrates (Van Eenennaam *et al.* 2001, Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001, Deng *et al.* 2002, Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen and Crocker 2006).

3. Water Flow

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11°C – 19°C) (Mayfield and Cech 2004, Van Eenennaam *et al.* 2005, Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs [average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown (2007)]. In Oregon's Rogue River, nDPS green sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10°C and flows increased (Erickson *et al.* 2002). On the Klamath River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al* 2007). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11°C – 17°C (optimal range = 14°C – 16°C) in spawning reaches for egg incubation (March-August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield and Cech 2004, Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 parts per thousand [ppt]) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen and Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages (ranging from 61.78 to 76.06 mg O^2 hr^{-1} kg^{-1} for juveniles, Allen and Cech [2007]). Suitable water quality would also include water with acceptably low levels of contaminants (*i.e.*, pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on effect of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a, 2001b, Feist *et al.* 2005, Fairey *et al.* 1997, Kruse and Scarnecchia 2002). Legacy contaminants such as mercury still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, the San Joaquin River basin, and the Delta.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

6. Depth

Deep pools of $\geq$ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of GCID. The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002, Benson *et al.* 2007). Approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants [*e.g.*, elevated levels of heavy metals (*e.g.*, mercury, copper, zinc, cadmium, and chromium), polycyclic aromatic hydrocarbons (PAHs), and organochlorine pesticides] that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may negatively affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate the sequestered contaminants into the river. This is a continuing concern throughout the watershed.

For Estuarine Habitats

1. Food Resources

Abundant food items within estuarine habitats and substrates for juvenile, subadult, and adult life stages are required for the proper functioning of this PCE for green sturgeon. Green sturgeon feed primarily on worms, mollusks, and crustaceans (Moyle 2002). Radtke (1966) studied the diet of juvenile sDPS green sturgeon and found their stomach contents to include mysid shrimp, amphipods, and other unidentified shrimp. These prey species are critical for the rearing, foraging, growth, and development of juvenile, subadult, and adult green sturgeon within the bays and estuaries. Currently, the estuary provides these food resources, although annual fluctuations in the population levels of these food resources may diminish the contribution of one group to the diet of green sturgeon relative to another food source.

Invasive species are a concern because they may replace the natural food items consumed by green sturgeon. The Asian overbite clam (*Corbula amurensis*) is one example of a prolific invasive clam species in the Delta. It has been observed to pass through the white sturgeon's digestive tract undigested (Kogut 2008).

2. Water Flow

Within bays and estuaries adjacent to the Sacramento River (*i.e.*, the Delta and the Suisun, San Pablo, and San Francisco bays), sufficient flow into the bay and estuary to allow adults to successfully orient to the incoming flow and migrate upstream to spawning grounds is required. Sufficient flows are needed to attract adult green sturgeon to the Sacramento River from the bay and to initiate the upstream spawning migration into the upper river. The specific quantity of flow required is a topic of ongoing research.

3. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics, is necessary for normal behavior, growth and viability of all life stages. Suitable water temperatures for juvenile green sturgeon should be below 24°C (75°F). At temperatures above 24°C, juvenile green sturgeon exhibit decreased swimming performance (Mayfield and Cech 2004) and increased cellular stress (Allen *et al.* 2006). Suitable salinities in the estuary range from brackish water (10 ppt) to salt water (33 ppt). Juveniles transitioning from brackish to salt water can tolerate prolonged exposure to salt water salinities, but may exhibit decreased growth and activity levels (Allen and Cech 2007), whereas subadults and adults tolerate a wide range of salinities (Kelly *et al.* 2007). Subadult and adult green sturgeon occupy a wide range of DO levels, but may need a minimum DO level of at least 6.54 mg O^2/l (Kelly *et al.* 2007, Moser and Lindley 2007).

Suitable water quality also includes water free of contaminants (*e.g.*, pesticides, organochlorines, elevated levels of heavy metals) that may disrupt the normal development of juvenile life stages, or the growth, survival, or reproduction of subadult or adult stages. In general, water quality in the Delta and estuary meets these criteria, but local areas of the Delta and downstream bays have been identified as having deficiencies. Discharges of agricultural drain water have also been implicated in local elevations of pesticides and other related agricultural compounds within the Delta and the tributaries and sloughs feeding into the Delta. Discharges from petroleum refineries in Suisun and San Pablo bay have been identified as sources of selenium to the local aquatic ecosystem (Linville *et al.* 2002).

4. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for timely passage of adult, sub-adult, and juvenile fish within the region's different estuarine habitats and between the upstream riverine habitat and the marine habitats. Within the waterways comprising the Delta, and bays downstream of the Sacramento River, safe and unobstructed passage is needed for juvenile green sturgeon during the rearing phase of their life cycle. Passage within the bays and the Delta is also critical for adults and subadults for feeding and summer holding, as well as to access the Sacramento River for their upstream spawning migrations and to make their outmigration back into the ocean. Within bays and estuaries outside of the Delta and the areas comprised by Suisun, San Pablo, and San Francisco bays, safe and unobstructed passage is necessary for adult and subadult green sturgeon to access feeding areas, holding areas, and thermal refugia, and to ensure passage back out into the ocean. Currently, safe and unobstructed passage has been diminished by human actions in the Delta and bays. The CVP and SWP, responsible for large volumes of water diversions, alter flow patterns in the Delta due to export pumping and create entrainment issues in the Delta at the pumping and Fish Facilities. Power generation facilities in Suisun Bay create risks of entrainment and thermal barriers through their operations of cooling water diversions and discharges. Installation of seasonal barriers in the South Delta and operations of the radial gates in the Delta Cross Channel (DCC) facilities alter migration corridors available to green sturgeon. Actions such as the hydraulic dredging of ship channels and operations of large ocean going vessels create additional sources of risk to green sturgeon within the estuary. Commercial shipping traffic can result in the loss of fish, particularly adult fish, through ship and propeller strikes.

5. Water Depth

A diversity of depths is necessary for shelter, foraging, and migration of juvenile, subadult, and adult life stages. Subadult and adult green sturgeon occupy deep (≥5 m) holding pools within bays, estuaries, and freshwater rivers. These deep holding pools may be important for feeding and energy conservation, or may serve as thermal refugia (Benson *et al.* 2007). Tagged adults and subadults within the San Francisco Bay estuary primarily occupied waters with depths of less than 10 meters, either swimming near the surface or foraging along the bottom (Kelly *et al.* 2007). In a study of juvenile green sturgeon in the Delta, relatively large numbers of juveniles were captured primarily in shallow waters from 3 – 8 feet deep, indicating juveniles may require shallower depths for rearing and foraging (Radtke 1966).

Currently, there is a diversity of water depths found throughout the San Francisco Bay estuary and Delta waterways. Most of the deeper waters, however, are composed of artificially maintained shipping channels, which do not migrate or fluctuate in response to the hydrology in the estuary in a natural manner. Shallow waters occur throughout the Delta and San Francisco Bay. Extensive "flats" occur in the lower reaches of the Sacramento and San Joaquin river systems as they leave the Delta region and are even more extensive in Suisun and San Pablo bays. In most of the region, variations in water depth in these shallow water areas occur due to natural processes, with only localized navigation channels being dredged (*e.g.*, the Napa River and Petaluma River channels in San Pablo Bay).

6. Sediment Quality

Sediment quality (*i.e.*, chemical characteristics) is necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*e.g.*, elevated levels of selenium, PAHs, and organochlorine pesticides) that can cause negative effects on all life stages of green sturgeon (see description of *sediment quality* for riverine habitats above).

Summary of the Conservation Value of Green Sturgeon Critical Habitat

The current condition of critical habitat for the green sturgeon sDPS is degraded over its historical conditions. It does not provide the full extent of conservation values necessary for the survival and recovery of the species, especially in the upstream riverine habitat. In particular, passage and water flow PBFs have been impacted by human actions, substantially altering the historical river characteristics in which the green sturgeon sDPS evolved. The habitat values proposed for green sturgeon critical habitat have suffered similar types of degradation as described for other listed Chinook salmon and steelhead critical habitats. In addition, the alterations to the lower Sacramento River and delta may have a particularly strong impact on the survival and recruitment of juvenile green sturgeon due to the protracted rearing time in the delta and estuary. Loss of individuals during this phase of the life history of green sturgeon represents losses to multiple year classes, which can ultimately impact the potential population structure for decades.

2.3 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.3.1 Water Development

The diversion and storage of natural flows by dams and diversion structures on Central Valley watersheds has depleted stream flows in the tributaries feeding the Delta and altered the natural cycles by which juvenile and adult salmonids and sDPS green sturgeon base their migrations. As much as 60 percent of the natural historical inflow to Central Valley watersheds and the Delta have been diverted for human uses. Depleted flows have contributed to higher temperatures, lower DO levels, and decreased recruitment of gravel and large woody debris (LWD, also referred to as instream woody material or IWM). More uniform flows year round have resulted in diminished natural channel formation, altered foodweb processes, and slower regeneration of riparian vegetation (Mount 1995).

Water withdrawals, for agricultural and municipal purposes have reduced river flows and increased temperatures during the critical summer months, and in some cases, have been of a sufficient magnitude to result in reverse flows in the lower San Joaquin River (Reynolds *et al.* 1993). Direct relationships exist between water temperature, water flow, and juvenile salmonid survival (Brandes and McLain 2001). Elevated water temperatures in the Sacramento River have limited the survival of young salmon in those waters. Juvenile fall-run survival in the Sacramento River is also directly related with June streamflow and June and July Delta outflow (Dettman *et al.* 1987).

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Central Valley. Thousands of small and medium-size water diversions exist along the Sacramento River, San Joaquin River, and their tributaries as well as in the maze of Delta waterways surrounding the intensively farmed islands within the legal Delta boundaries. Although efforts have been made in recent years to screen some of these diversions, many remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile salmonids and green sturgeon. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a Central Valley database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001).

2.3.2 Water Conveyance and Flood Control

The development of the water conveyance system in the Delta has resulted in the construction of more than 1,100 miles of armored levees to increase channel flood capacity elevations and flow capacity of the channels (Mount 1995). Levee development in the Central Valley affects spawning habitat, freshwater rearing habitat, freshwater migration corridors, and freshwater riverine and estuarine habitat PBFs. As Mount (1995) indicates, there is an "underlying, fundamental conflict inherent in this channelization." Natural rivers strive to achieve dynamic equilibrium to handle a watershed's supply of discharge and sediment (Mount 1995). The construction of levees disrupts the natural processes of the river, resulting in a multitude of habitat-related effects; including isolation of the watershed's natural floodplain behind the levee from the active river channel and its fluctuating hydrology.

Many of these levees use angular rock (riprap) to armor the bank from erosive forces. The effects of channelization, and riprapping, include the alteration of river hydraulics and cover along the bank as a result of changes in bank configuration and structural features (Stillwater Sciences 2006). These changes affect the quantity and quality of nearshore habitat for juvenile salmonids and have been thoroughly studied (USFWS 2000, Schmetterling *et al.* 2001, Garland *et al.* 2002). Simple slopes protected with rock revetment generally create nearshore hydraulic conditions characterized by greater depths and faster, more homogeneous water velocities than occur along natural banks. Higher water velocities typically inhibit deposition and retention of sediment and woody debris. These changes generally reduce the range of habitat conditions typically found along natural shorelines, especially by eliminating the shallow, slow-velocity river margins used by juvenile fish as refuge and escape from fast currents, deep water, and predators (Stillwater Sciences 2006).

2.3.3 Land Use Activities

Since the 1850s, wetlands reclamation for urban and agricultural development has caused the cumulative loss of 79 and 94 percent of the tidal marsh habitat in the Delta downstream and upstream of Chipps Island, respectively (Conomos *et al.* 1985, Nichols *et al.* 1986, Wright and Phillips 1988, Goals Project 1999). Prior to 1850, approximately 1400 km^2 of freshwater marsh surrounded the confluence of the Sacramento and San Joaquin Rivers, and another 800 km^2 of saltwater marsh fringed San Francisco Bay's margins. Of the original 2,200 km^2 of tidally influenced marsh, only about 125 km^2 of undiked marsh remains today. Even more extensive losses of wetland marshes occurred in the Sacramento and San Joaquin River basins. Little of the extensive tracts of wetland marshes that existed prior to 1850 along the valley's river systems and within the natural flood basins exist today. Most has been "reclaimed" for agricultural purposes, leaving only small remnant patches. Engineered levees have isolated the rivers from their natural floodplains and have resulted in the loss of their ecological functions.

Dredging of river channels to enhance inland maritime trade and to provide raw material for levee construction has significantly and detrimentally altered the natural hydrology and function of the river systems in the Central Valley. Starting in the mid-1800s, the Corps and other private consortiums began straightening river channels and artificially deepening them to enhance shipping commerce. This has led to declines in the natural meandering of river channels and the formation of pool and bar segments. The deepening of channels beyond their natural depth also has led to a significant alteration in the transport of bedload in the riverine system as well as the local flow velocity in the channel (Mount 1995). The Sacramento Flood Control Project at the turn of the nineteenth century ushered in the start of large scale Corps actions in the Delta and along the rivers of California for reclamation and flood control. The creation of levees and the deep shipping channels reduced the natural tendency of the San Joaquin and Sacramento rivers to create floodplains along their banks with seasonal inundations during the wet winter season and the spring snow melt periods. These annual inundations provided necessary habitat for rearing and foraging of juvenile native fish that evolved with this flooding process. The armored riprapped levee banks and active maintenance actions of Reclamation Districts precluded the establishment of ecologically important riparian vegetation, introduction of valuable LWD from these riparian corridors, and the productive intertidal mudflats characteristic of the undisturbed Delta habitat.

Urban stormwater and agricultural runoff may be contaminated with pesticides, oil, grease, heavy metals, PAHs, and other organics and nutrients (Regional Board 1998), which can destroy aquatic life necessary for salmonid survival (NMFS 1996a, b) and are also expected to negatively impact the different green sturgeon life stages also present. Point source (PS) and non-point source (NPS) pollution occurs at almost every point that urbanization activity influences the watershed. Impervious surfaces (*i.e.*, concrete, asphalt, and buildings) reduce water infiltration and increase runoff, thus creating greater flood hazard (NMFS 1996a, b). Flood control and land drainage schemes may increase the flood risk downstream by concentrating runoff. A flashy discharge pattern results in increased bank erosion with subsequent loss of riparian vegetation, undercut banks and stream channel widening. In addition to the PS and NPS inputs from urban runoff, juvenile salmonids and green sturgeon are exposed to increased water temperatures as a result of thermal inputs from municipal, industrial, and agricultural discharges.

2.3.4 Water Quality

The water quality of the Delta has been negatively impacted over the last 150 years. Increased water temperatures, decreased DO levels, and increased turbidity and contaminant loads have degraded the quality of the aquatic habitat for the rearing and migration of salmonids and sDPS green sturgeon. Some common pollutants include effluent from wastewater treatment plants and chemical discharges such as dioxin from San Francisco Bay petroleum refineries (McEwan and Jackson 1996). In addition, agricultural drain water, another possible source of contaminants, can contribute up to 30 percent of the total inflow into the Sacramento River during the low-flow period of a dry year. The Regional Board, in its 1998 Clean Water Act §303(d) list characterized the Delta as an impaired waterbody having elevated levels of chlorpyrifos, dichlorodiphenyltrichlor (*i.e.* DDT), diazinon, electrical conductivity, Group A pesticides [aldrin, dieldrin, chlordane, endrin, heptachlor, heptachlor epoxide, hexachlorocyclohexanes (including lindane), endosulfan and toxaphene], mercury, low DO, organic enrichment, and unknown toxicities (Regional Board 1998, 2001, 2010).

In general, water degradation or contamination can lead to either acute toxicity, resulting in death when concentrations are sufficiently elevated, or more typically, when concentrations are lower, to chronic or sublethal effects that reduce the physical health of the organism, and lessens its survival over an extended period of time. Mortality may become a secondary effect due to compromised physiology or behavioral changes that lessen the organism's ability to carry out its normal activities. For example, increased levels of heavy metals are detrimental to the health of an organism because they interfere with metabolic functions by inhibiting key enzyme activity in metabolic pathways, decrease neurological function, degrade cardiovascular output, and act as mutagens, teratogens or carcinogens in exposed organisms (Rand *et al.* 1995, Goyer 1996). For listed species, these effects may occur directly to the listed fish or to its prey base, which reduces the forage base available to the listed species.

In the aquatic environment, most anthropogenic chemicals and waste materials, including toxic organic and inorganic chemicals eventually accumulate in sediment (Ingersoll 1995). Direct exposure to contaminated sediments may cause deleterious effects to listed salmonids and green sturgeon. This may occur if a fish swims through a plume of the resuspended sediments or rests on contaminated substrate and absorbs the toxic compounds through one of several routes: dermal contact, ingestion, or uptake across the gills. Elevated contaminant levels may be found in localized "hot spots" where discharge occurs or where river currents deposit sediment loads. Sediment contaminant levels can thus be significantly higher than the overlying water column concentrations (USEPA 1994). However, the more likely route of exposure to salmonids or green sturgeon is through the food chain, when the fish feed on organisms that are contaminated with toxic compounds. Prey species become contaminated either by feeding on the detritus associated with the sediments or dwelling in the sediment itself. Therefore, the degree of exposure to the salmonids and green sturgeon depends on their trophic level and the amount of contaminated forage base they consume. Response of salmonids and green sturgeon to contaminated sediments is similar to water borne exposures once the contaminant has entered the body of the fish.

2.3.5 Hydrology in the Delta

Substantial changes have occurred in the hydrology of the Central Valley's watersheds over the past 150 years. Many of these changes are linked to the ongoing actions of the CVP and SWP in their pursuit of water storage and delivery of this water to their contractors.

Prior to the construction of dams on the tributaries surrounding the Central Valley, parts of the valley floor hydrologically functioned as a series of natural reservoirs seasonally filling and draining every year with the cycles of rainfall and snow melt in the surrounding watersheds. These reservoirs delayed and muted the transmission of floodwaters traveling down the length of the Sacramento and San Joaquin rivers. Historically, there were at least six distinct flood basins in the Sacramento Valley. These extensive flood basins created excellent shallow water habitat for fish such as juvenile Chinook salmon, steelhead, and sturgeon to grow and rear before moving downstream into the Delta (The Bay Institute 1998). The magnitude of the seasonal flood pulses were reduced before entering the Delta, but the duration of the elevated flows into the Delta were prolonged for several months, thereby providing extended rearing opportunities for emigrating Chinook salmon, steelhead, and green sturgeon to grow larger and acquire additional nutritional energy stores before entering the main Delta and upper estuarine reaches.

Prior to the construction of dams, there were distinct differences in the natural seasonal flow patterns between the northern Sacramento River watershed and the southern San Joaquin River watershed. Furthermore, the natural unimpaired runoff in the Central Valley watersheds historically showed substantial seasonal and inter-annual variability. Watersheds below 5,000 feet in elevation followed a hydrograph dominated by rainfall events with peak flows occurring in late fall or early winter (northern Sierra Nevada, Cascade Range, and most of the western coastal mountains). Conversely, those watersheds with catchment areas above 5,000 feet, such as the Central and Southern Sierras, had hydrographs dominated by the spring snowmelt runoff period and had their highest flows in the late spring/early summer period. Summertime flows on the valley floor were considerably reduced after the seasonal rain and snowmelt pulses were finished (see Figure 8), with base flows supported by the stored groundwater in the surrounding alluvial plains. Since the construction of the more than 600 dams in the mountains surrounding the Central Valley, the variability in seasonal and inter-annual runoff has been substantially reduced and the peak flows muted, except in exceptional runoff years. Currently, average winter/spring flows are typically reduced compared to natural conditions, while summer/fall flows have been artificially increased by reservoir releases. Wintertime releases are coordinated for preserving flood control space in the valley's large terminal storage dams, and typically do not reach the levels necessary for bed load transport and reshaping of the river channels below the dams. Summertime flows have been scheduled for meeting water quality goals and consumptive water demands downstream (see Figures 9 and 10). Mean outflow from the Sacramento River during the later portion of the 19th century has been reduced from nearly 50 percent of the annual discharge occurring in the period between April and June to only about 20 percent of the total mean annual outflow under current dam operations (The Bay Institute 1998). Currently, the highest mean flows occur in January, February, and March. The San Joaquin River has seen its snowmelt flood peak essentially eliminated, and the total discharge to the valley floor portion of the mainstem greatly reduced during the spring. Only in very wet years is there any marked late spring outflow peak (The Bay Institute 1998).

These changes in the hydrographs of the two main river systems in the Central Valley are also reflected in the inflow and outflow of water to the Delta. The operations of the dams and water transfer operations of the CVP and SWP have reduced the winter and spring flows into the Delta, while artificially maintaining elevated flows in the summer and late fall periods. The Delta has thus become a conveyance apparatus to move water from the Sacramento side of the Delta to the southwestern corner of the Delta where the CVP and SWP pumping facilities are located. Releases of water to the Delta during the normally low flow summer period have had several impacts on Delta ecology and hydrology. Since the projects started transferring water through the Delta, the normal variability in the hydrology of the Delta has diminished. Annual incursions of saline water into the Delta still occur each summer, but have been substantially muted compared to their historical levels by the release of summer water from the reservoirs (Herbold and Moyle 1989, see Figures 11 and 12). The Delta has become a stable freshwater body, which is more suitable for introduced and invasive exotic freshwater species of fish, plants, and invertebrates than for the native organisms that evolved in a fluctuating and "unstable" Delta environment.

Furthermore, Delta outflow has been reduced by approximately 14 percent from the pre-dam period (1921-1943) when compared to the modern state and federal water project operations period (1968-1994). When differences in the hydrologic year types are accounted for and the "wet" years are excluded, the comparison between similar year types indicates that outflow has been reduced by 30 to 60 percent (The Bay Institute 1998), with most of this "lost" water going to exports. Currently, the Sacramento River contributes roughly 75-80% of the Delta inflow in most years and the San Joaquin River contributes about 10-15%; the Mokelumne, Cosumnes, and Calaveras rivers, which enter into the eastern side of the Delta, contribute the remainder. The sum of the river contributions flow through the Delta and into Suisun Bay, San Pablo Bay, San Francisco Bay, and eventually empties into the Pacific Ocean. Historical annual Delta inflow between 1945 and 1995 (*i.e.*, the period of modern dam operations) averaged approximately 23 million acre-feet (MAF), with a minimum inflow of approximately 6 MAF in 1977 and a maximum of approximately 70 MAF in 1983 (Corps 2015).

Water movement in the Delta responds to four primary forcing mechanisms: (1) freshwater inflows draining to the ocean; (2) Delta exports and diversions; (3) operation of water control facilities such as dams, export pumps, and flow barriers; and (4) the regular tidal movement of seawater into and out of the Delta. In addition, winds and salinity behavior within the Delta can generate a number of secondary currents that, although of low velocity, can be of considerable significance with respect to transporting contaminants and mixing different sources of water. Changes in flow patterns within the Delta, whether caused by export pumping, winds, atmospheric pressure, flow barriers, tidal variations, inflows, or local diversions, can influence water quality at drinking water intakes (Corps 2015).

2.3.6 Vegetation

Historic native vegetation in the Project area has been highly altered and fragmented as a result of flood risk management, land reclamation, urbanization, agriculture, and navigation projects (Corps 2015). Flood risk management infrastructure in this area includes levees, river and tributary realignments, constructed channels, erosion protection, and control structures. Vegetation within the Project area maintains some remnants of what was historically present, including Great Valley cottonwood riparian forest, Great Valley oak riparian forest, coastal and valley freshwater marsh. It also includes nonnative woodlands, agricultural (row crops, orchards and vineyards), and developed lands like lawns, parks and golf courses. Non-native grasses, forbs, shrubs, trees, and vines are interwoven throughout the landscape. Open water habitat includes rivers, tributaries, canals, and ditches. Ditches may contain water seasonally or year-round (Corps 2015).

Once, the San Joaquin River and tributaries were framed by dense riparian forest. Today, riparian vegetation consists of narrow linear strips and occasional patches of riparian forest and riparian scrub growing on or adjacent to the levee. Larger areas of riparian forest are present in some areas where the levee is set back from the river or tributary leaving floodplain on the waterside of the levee (Corps 2015).

The Project area occurs within the Great Central Valley subdivision of the California floristic Province in San Joaquin County (Hickman, Ed. 1993:45). The topography of the portions of the Project area adjacent to the levees is relatively level, and elevations in the Project area range from less than 5 feet to approximately 38 feet above mean sea level. The northern portion of the Project area includes Mosher Slough, Fivemile Slough, Fourteenmile Slough, Tenmile Slough, and the Stockton Deep Water Ship Channel. The central and southern part of the Project area includes the San Joaquin River and its tributaries, including Calaveras River, Smith Canal, Mormon Slough, French Camp Slough, and Duck Creek. The following sections describe the vegetation found in the Project action area.

Mosher Slough

Mosher Slough runs through a highly urbanized area in north Stockton. Woody riparian vegetation is most robust near the confluence with Fourteenmile Slough. It is comprised of typical Great Valley riparian trees and shrubs. Emergent wetland vegetation occurs intermittently at the water's edge. Landside vegetation includes non-native landscape trees and shrubs as well as natives. Typical wetland vegetation lines some stretches of this reach (Corps 2015).

Fourteenmile, Fivemile, and Tenmile sloughs

These levees along these waterways protect the western edge of the City of Stockton. Westward of the waterways the region is predominantly agricultural lands. To the east of the waterways are highly urbanized areas consisting of housing subdivisions and light industry. On the waterside of the levees, some woody riparian trees and shrubs still remain. Within some of the sloughs and canals, native and non-native aquatic weeds cover much of the water surface. Along the edges of the waterways wetland vegetation is present intermittently. Within Fourteenmile Slough, intertidal vegetation is present on rocky substrate that is exposed during low tides. In Buckley Cove, near the confluence of Tenmile Slough with the Stockton DWSC, wetland and subtidal vegetation is present along with native and non-native aquatic weeds (Corps 2015). .

San Joaquin River

On the San Joaquin River, lands waterside of the levees are very narrow and support a remnant riparian forest. Trees and shrubs occur in small patches or by scattered individuals. Vegetation on the waterside of levee slopes in the Project area is highly varied, ranging from ruderal herbaceous vegetation and annual grasses with few shrubs, to dense shrubs with little overstory, to mature riparian forest. Potential SRA cover is found along much of the river in the Project area.

Dominant waterside tree species include cottonwood (*Populus fremontii*), willow (*Salix* spp.), oak (*Quercus* spp.), box elder (*Acer negundo*), and walnut trees (*Juglans* spp.). In the Project area, common shrub species include willow, wild Rose (*Rosa* spp.), and blackberry (*Rubus* spp.). Elderberry shrubs (*Sambucus* spp.) are also present in some locations. Ruderal herbaceous vegetation is commonly present on waterside levee slopes. Landside levee slopes are primarily barren or covered with ruderal vegetation.

Calaveras River

Levees and the lands adjacent to both the waterside and landside of the levees in the reach of the Calaveras River above, and just below, the Stockton Diverting Canal are largely devoid of trees and shrubs. Moving downstream, more trees and shrubs are present on and adjacent to the levees. In the highly urbanized reaches of the river channel, many of the landside trees and shrubs are associated with landscape plantings in yards, parks, and public rights of way. Wetland vegetation appears to line the channel in places. Within the river channel, between the levee faces, seasonally inundated lands exist with riparian and ruderal vegetation consisting of grasses, bushes, and shrubs.

Smith Canal

Smith canal is surrounded by urban residential areas, including hard-scaping (sidewalks) and some landscape plantings adjacent to the water's edge. Near the confluence of the canal with the San Joaquin River, there is a public park, including a picnic area, boat launch ramp and associated infrastructure. There is an irrigated lawn and a mixture of native and non-native trees and shrubs. Wetland vegetation is prevalent at the water's edge and non-native invasive water plants inhabit the canal near the boat launch ramp. Non-native invasive waterweeds occupy much of the inlet in the vicinity of the boat launch ramp.

French Camp Slough and Duck Creek

The Corps' BA (Corps 2015) describes the levees along Duck Creek as devoid of trees and shrubs. Adjacent lands are largely in agriculture with urban development beginning to encroach upon these lands. French Camp Slough upstream of the confluence with Duck Creek is very similar in character to Duck Creek. Levees are free of trees and shrubs and adjacent lands are in agriculture with urban lands extending towards the levee slough.

The lower reaches of French Camp Slough (between Duck Creek and the San Joaquin River) are surrounded on the landward side by urban development. The Weston Ranch residential development is immediately to the south of the slough. A municipal golf course occupies land adjacent to the northern bank/levee of French Camp Slough. Between the north and south French Camp Slough levees there exists an "island" of land that is in agriculture. The perimeter of this island contains a fairly thick margin of trees and shrubs adjacent to the slough's waters (Corps 2015).

In the lower French Camp Slough reach, the levee crown includes a paved road. The landside levee slope and toe are mostly devoid of vegetation. There are some annual grasses and herbs. These are largely non-native weedy plants. Where trees and shrubs are present within the landside easement, they are mainly landscape plantings associated with public rights of way and private yards. The waterside levee slope and easement have trees and shrubs throughout their length, being quite dense in some areas. Trees include native valley oak, box elder, cottonwood, California black walnut, and willows. Elderberry shrubs, poison oak (*Toxicodendron diversilobum*), patches of dead willow shrubs, and snags also are present. In the canal between the southern levee and the mid-channel island to the north, wetland plants are abundant. These include tules (*Scirpus* spp.), nut sedges (*Cyperus* spp.), and tule potato (*Sagittaria* spp.). Non-native English walnut trees, water hyacinth (*Eichhornia crassipes*), and mistletoe (order *santalales*) are also present (Corps 2015).

2.3.7 Status of Species in the Action Area

1. Presence of CV Spring-run in the Action Area

Currently there are no documented populations of CV spring-run in the San Joaquin River basin that would likely occur in the action area. However, there is anecdotal evidence of Chinook salmon occurring in the Stanislaus and Tuolumne Rivers that may represent residual populations of spring-run Chinook salmon or individuals that have strayed from other river basins and use the Stanislaus and Tuolumne rivers for spawning based on their run timing and the presence of fry and juveniles that show traits characteristic of spring-run populations such as hatching dates and seasonal sizes (Franks 2013). Furthermore, the SJRRP goal of re-establishing an experimental population of CV spring-run in the San Joaquin River basin will create the potential that spring-run Chinook salmon will be present in the action area over the Project's construction time frame through 2028 and continued presence of the flood control structures and levees in the action area into the future.

There are no spawning areas in the action area that could be used by adult spring-run, therefore the potential that eggs would be present in the action area is essentially nonexistent. Likewise, the potential for alevins to be present in the action area is also unlikely, since only extreme precipitation events in the fall and early winter resulting in high river flows in the San Joaquin River basin could flush alevins out of their natal tributaries into the action area. Fry and parr are more likely to be present in the action area in response to high river flows due to the timing of winter storms and the progressive maturation of the fish. This period would be from approximately November through March. By April, juvenile spring-run are reaching the size that smoltification occurs, and the smolts would be moving downriver to enter the Delta on their emigration to the ocean. Spring-run smolt outmigration is essentially over by mid-May and early June. There is the potential that some juvenile spring-run will remain in the tributaries through the summer and outmigrate the following fall and winter as yearlings, but until the experimental population has had time to establish itself, this behavior is uncertain to occur. Adult spring-run are expected to enter the action area starting in January. Low levels of adult migration is expected to continue through early March. The peak of adult migration through the action area is expected to occur between April and June, based on the migratory behavior of the Sacramento River basin stocks. Adult migration is also likely to be strongly influenced by the flow levels in the San Joaquin River basin that provides access to the upstream holding and spawning areas.

The proposed construction period for the Project's actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. There is very little likelihood that either adult or juvenile life history stages of CV spring-run would overlap with this timing. However, the long-term operations of the Project's flood control gates in Smith Canal would overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. This period would overlap with a portion of both the juvenile and adult salmon migration movements from April through June. It is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for salmonids. Large populations of non-native fish, such as centrarchids, are present and pose a predation threat to juveniles. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of non-natal rearing juvenile spring-run. Both adults and juveniles could easily access these waters during their migratory movements through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

2. Presence of CCV Steelhead in the Action Area

Small, but persistent populations of CCV steelhead are present in the Calaveras River and San Joaquin River basins and are part of the Southern Sierra Nevada Diversity group. Both adults and smolts are detected by monitoring efforts in these basins indicating spawning is occurring in the basin's tributaries. There are no spawning areas in the action area that could be used by adult

CCV steelhead, therefore the potential that eggs would be present in the action area is nonexistent. All adult CCV steelhead originating in the Calaveras River watershed will have to migrate through the action area to reach their spawning grounds and return to the ocean following spawning. Likewise it is believed that the majority of adult CCV steelhead originating in the San Joaquin River basin will pass through the action area to reach their spawning grounds in the Stanislaus, Tuolumne, and Merced rivers, and the tailwater section of the San Joaquin River below Friant Dam, and return to the ocean following spawning through these same waterways. Some adults may access the San Joaquin River basin through the south Delta waterways leading to the Head of Old River near Lathrop, and may return to the ocean via this route too. These fish would avoid the action area if they use this alternative route. Likewise all CCV steelhead smolts originating in the Calaveras River watershed will have to pass through the action area in the lower reaches of the river where it empties into the San Joaquin River during their emigration to the ocean. CCV steelhead smolts leaving the San Joaquin River basin during their emigration also have the potential to pass through the action area, particularly if a fish barrier is installed at the Head of Old River during their emigration period. The waterways in the action area are expected to be used primarily as migration corridors for adult steelhead and emigrating steelhead smolts, but may also provide some rearing benefits to the emigrating smolts.

CCV steelhead smolts are expected to appear in the action area waterways as early as January, based on observations in tributary monitoring studies on the Mokelumne, Calaveras, and Stanislaus rivers, but in very low numbers. The emigration out of the tributaries starts to increase in February and peaks in March, with fish continuing to be observed through late May and June. The peak emigration in the lower San Joaquin, as determined by the Mossdale trawls near the Head of Old River, occurs from April to May, but with presence of fish typically extending from late February to late June. It should be noted that emigration out of the Calaveras River can only occur if there is hydraulic continuity between the upper watershed below New Hogan Dam and the Delta. If the water year is dry with little rainfall in the Calaveras River watershed, the river may disconnect upstream of the Delta, and any steelhead smolts still within the lower reaches of the Calaveras River, Mormon Slough, and the Diverting Canal will be stranded and will perish.

Adult CCV steelhead are expected to start moving upstream through the action area into the lower San Joaquin River as early as September, with the peak migration period occurring later in the fall during the November through January period, based on Stanislaus River fish weir counts. Adult CCV steelhead will continue to migrate upriver through March, with post spawn fish, "kelts", moving downstream potentially through spring and early summer, although most are expected to move back downstream earlier than later.

The proposed construction period for the Project's actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. This will overlap with the adult CCV steelhead migration period in the San Joaquin River basin (*i.e.*, the months of September and October) but will avoid the peak of spawning migration from November through January. However, the long-term operations of the Project's flood control gates in Smith Canal may overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. This period would overlap with a portion of both the juvenile and adult migration movements from April through June and in the months of September and October when adults are migrating. It is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for salmonids. Large populations of non-native fish, such as centrarchids, are present and pose a predation threat to smolts. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of both adult and juvenile CCV steelhead. Both adults and juveniles are likely to be present in the waters of the Calaveras River during their migratory movements in the period between mid-April and June, particularly if there is hydraulic connection between the Delta and the upper reaches of the river. Presence in the waters of French Camp Slough is likely in the fall (adults) and in the spring (adults and smolts) due to the open access between the mainstem San Joaquin River and the slough during the migratory movements of adults and smolts through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

3. Presence of sDPS of North American Green Sturgeon in the Action Area

Both adult and juvenile green sturgeon are expected to occur in the action area, but in low numbers. The Delta serves as an important migratory corridor for adults during their spawning migrations, and as year round rearing habitat for juveniles. Both non-spawning adults and sub-adults use the Delta and estuary for foraging during the summer. Since there are no physical barriers to sDPS green sturgeon moving into the action area from the waters of the Delta adjacent to the action area during their rearing or foraging behaviors, presence in the action area is seen as feasible and likely.

Detailed information regarding historic and current abundance, distribution and seasonal occurrence of sDPS green sturgeon in the action area is limited due to a general dearth of green sturgeon monitoring. The action area is located on one of the two main rivers feeding the Delta (the San Joaquin River) and there have been consistent reports of green sturgeon being caught by sport fisherman in the San Joaquin River from Sherman Island at the western edge of the Delta upstream to at least Highway 140 near the town of Newman (CDFW 2015, 2014, 2013, 2012, 2011), although in low numbers compared to other regions of the Delta and San Francisco estuary. At this time, no specimen has been examined by trained biologists to determine if these fish caught and recorded in the sturgeon report card database are actually green sturgeon. Up until recently, juvenile green sturgeon from the sDPS were routinely collected at the State Water Project (SWP) and Central Valley Project (CVP) salvage facilities throughout the entire year. Based on the salvage records, green sturgeon may be present during any month of the year, and have been particularly prevalent during July and August. However, over the past few years, salvage of juvenile green sturgeon at the facilities has been rare (as well as for salvage of the more common white sturgeon); the reason for this decline in salvage is unknown. Adult green sturgeon begin to enter the Delta in February and early March during the initiation of their upstream spawning run. The peak of adult entrance into the Delta appears to occur in late February through early April with fish arriving upstream in April and May. Adults continue to enter the Delta until early summer (June-July) as they move upriver to spawn. It is also possible that some adult green sturgeon will be moving back downstream into the Delta in April and May, either as early post spawners or as unsuccessful spawners and may potentially enter the action area via the San Joaquin River. Some adult green sturgeon have been observed to rapidly move back downstream following spawning, while others linger in the upper river until the following fall, moving downstream with changes in water temperature and flows due to fall storms.

Because the only known spawning areas for sDPS green sturgeon occur in the Sacramento River basin, there is very low potential for eggs or larval green sturgeon to occur in the action area. Spawning in the San Joaquin River has not been recorded, although there appears to be at least some presence of adult fish in the river upstream of the Delta based on the sturgeon report card data.

The proposed construction period for the Project's actions in the mainstem San Joaquin portion of the action area is from mid-July through October 31. Since both adult and juvenile sDPS green sturgeon may be present in the Delta year round, the construction period will overlap with their presence. Likewise, the long-term operations of the Project's flood control gates in Smith Canal will overlap with both adult and juvenile presence in the Delta during the winter when river levels are expected to rise in response to high astronomical tides or flood events occur and the gates are operated. Likewise, the environmental effects of the long-term vegetation policies along the Project's levees will overlap with fish presence into the future.

The proposed construction period for the Project's actions in the tributaries and sloughs within the action area is from mid-April through October 31. Since both adult and juvenile presence is assumed to occur year round in the action area, the planned construction window for the sloughs and tributaries will overlap with their presence. However, it is unlikely that either juveniles or adults will be present in the waters of Fourteenmile, Fivemile, Mosher, or Tenmile sloughs based on the locations and environmental characteristics of these waterbodies. There are no known spawning areas upstream of these sloughs to attract adults, and very little inflows from upstream to create false attraction flows. These waterways are also removed from the main migratory routes used to access the mainstem San Joaquin River and currently have large sections blocked by non-native aquatic weeds such as *Egeria densa* and water hyacinth that create inhospitable habitat for native fish. Within the Calaveras River and French Camp Slough portions of the action area, construction during the mid-April through October 31 time period would overlap with the potential presence of both adult and juvenile sDPS green sturgeon. Both adults and juveniles could easily access these waters at the mouths of the Calaveras River or French Camp Slough during their movements through the San Joaquin River corridor. Like the San Joaquin River mainstem, the environmental effects of long-term vegetation policies will overlap with fish presence into the future.

2.3.8 Status of Critical Habitat within the Action Area

The PBFs for steelhead critical habitat within the action area include freshwater rearing habitat and freshwater migration corridors. Estuarine areas occur farther downstream where mixing occurs and salinity is greater than 0.5 ppt. The features of the PBFs included in these different sites essential to the conservation of the CCV steelhead DPS include the following: sufficient water quantity and floodplain connectivity to form and maintain physical habitat conditions necessary for salmonid development and mobility, sufficient water quality, food and nutrients sources, natural cover and shelter, migration routes free from obstructions, no excessive predation, holding areas for juveniles and adults, and shallow water areas and wetlands. Habitat within the action area is primarily utilized for freshwater rearing and migration by CCV steelhead smolts and for adult freshwater migration. No spawning of CCV steelhead occurs within the action area.

In regards to the designated critical habitat for the sDPS of North American green sturgeon, the action area includes PBFs which provide: adequate food resources for all life stages utilizing the Delta; water flows sufficient to allow adults, sub-adults, and juveniles to orient to flows for migration and normal behavioral responses; water quality sufficient to allow normal physiological and behavioral responses; unobstructed migratory corridors for all life stages utilizing the Delta; a broad spectrum of water depths to satisfy the needs of the different life stages present in the Delta and estuary; and sediment with sufficiently low contaminant burdens to allow for normal physiological and behavioral responses to the environment.

The general condition and function of the aquatic habitat has already been described in the *Rangewide Status of the Species and Critical Habitat* section of this Opinion. The substantial degradation over time of several of the essential critical elements has diminished the function and condition of the freshwater rearing and migration habitats in the action area.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the CCV steelhead DPS and the sDPS of North American green sturgeon. All juvenile CCV steelhead smolts originating in the Calaveras River basins must pass into and through the action area in the Central Delta to reach the lower Delta and the ocean. A large fraction of the CCV steelhead smolts originating in the San Joaquin River basin fish will likely pass downstream through the action area within the San Joaquin River mainstem channel, particularly if there is a fish barrier at the Head of Old River to prevent smolt entrance into that route. Likewise, adults migrating upstream to spawn are likely to pass through the action area within the main stem of the San Joaquin River to reach their upstream spawning areas in the Calaveras River basin or the San Joaquin River basin. Therefore, it is of critical importance to the long-term viability of the CCV steelhead to maintain a functional migratory corridor and freshwater rearing habitat through the action area to sustain the Southern Sierra Diversity Group, and provide the necessary spatial diversity to achieve recovery. Due to a deficit of monitoring data directed at this species, an unknown fraction of the sDPS population utilizes the middle and upper San Joaquin River reaches within the Delta, and even less is known about utilization of the San Joaquin River upstream of the Delta. However, designated critical habitat occurs in the action area and includes the San Joaquin River upstream to the limits of the legal Delta (Vernalis) on the San Joaquin River. Preservation of the functionality of the PBFs within this region is important to the long term viability of the sDPS green sturgeon population by providing suitable habitat for the rearing of juveniles, and the foraging and migratory movements of adults.

2.3.9 Factors Affecting the Species and Habitat in the Area

The action area encompasses a small portion of the area utilized by CCV steelhead as well as the sDPS of North American green sturgeon. Many of the factors affecting these species in the action area are considered the same as throughout their range, as discussed in the *Rangewide Status of the Species and Critical Habitat* and *Environmental Baseline* sections of this Opinion, specifically, levee armoring and channelization, alteration of river flows and timing, reduction of LWD in the waterways, reduction of riparian corridors and associated SRA vegetation and the introduction of point and non-point contaminants and are incorporated here by reference.

2.4 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

To conduct this assessment, NMFS examined information from a variety of sources. Detailed background information on the status of these species and critical habitat has been published in a number of documents including peer reviewed scientific journals, primary reference materials, government and non-government reports, the BA for this project, and supplemental material provided by the applicant in response to questions asked by NMFS.

2.4.1 Assessment

The assessment of Project effects will first look at construction related effects and then effects related to the long term impacts of the levees, loss of riparian vegetation, and implementation of the Corps' ETL vegetation policy. NMFS review of construction related effects will examine impacts from terrestrial and aquatic construction activities including noise related and short term turbidity effects upon listed species. Secondly, NMFS assessed the effects of the long term operation of the flood control structures on listed species, including entrapment, water quality, and vulnerability to predation. Next, NMFS examined the role of the physical presence of levee structures and the armoring of the levee faces with riprap on the functioning of aquatic and riparian communities, food webs, and utilization of these altered habitats by listed salmonids and green sturgeon. Finally, NMFS evaluated the impacts of the Project's actions on designated critical habitat in the action area.

2.4.1.1 Construction Related Effects

The proposed Project has both terrestrial and aquatic habitat construction impacts. The construction related effects will be comprised of two main effects: noise related impacts and turbidity related impacts. Noise related impacts will occur contemporaneously with the construction activities, and will be associated primarily with the use of heavy construction equipment on the levees, the use of excavators or drilling equipment to modify the levees for flood protection, and the use of pile drivers to install sheet pile walls and concrete columns. When construction activities are halted, noise generation ceases. This is considered a direct effect of the construction process related to the Project. In contrast, the construction related impacts associated with turbidity have a more complex temporal pattern. During construction, soils and sediments may become disturbed and directly suspended in the surrounding waterways, creating turbidity events adjacent to the levees under construction and in the nearby waterways as the turbidity plume is disbursed by water movement. This is the immediate temporal exposure to turbidity events related to construction activities and is considered a direct effect of the Project. Long term exposure to turbidity events can occur due to the erosion of exposed soil surfaces during or following the completion of construction activities and can occur weeks to months after the completion of Project activities during precipitation events and is considered an indirect effect of the construction process of the Project.

1. Noise related effects

Terrestrial Construction Sources

Based on the description provided in the Corps BA regarding construction elements of the Project (Corps 2015), heavy equipment will be used throughout the action area to implement the different levee improvements considered in the Project description. Heavy earth moving equipment will be used to clear and grub the levee faces on both the waterside and landsides of the levees undergoing structural flood risk improvements. Following this, the crown of the levee will typically be degraded, removing up to 50 percent of the levee height to create the suitable width for construction actions. This will require equipment such as bulldozers, scrapers, front loaders, and dump trucks to haul away the soil from the levee site for offsite storage. Construction of cutoff walls will require the use of excavators to dig the cutoff wall trench or the excavation of soils using specialized drilling equipment to inject the bentonite slurry into the cutoff wall space using deep soil mixing techniques. A similar drilling technique will also be used in the seismic remediation elements where installation of a larger grid of soil-cement mixed columns laid out in a series of overlapping cells running longitudinally and perpendicular to the levee alignment will be created. Reconstruction of the modified levees to achieve the appropriate levee prism will require new fill to be brought in by haul trucks and spread on the levee surfaces. Various earth moving equipment, including scrapers and soil compactors will be used to complete the levee construction to Corps design criteria.

All of these construction elements and the associated construction equipment required to complete the action will create noise in the terrestrial environment, particularly when heavy earth moving equipment is used. The scraping and moving of earth will create noise as energy is being transferred from the hard blades or buckets of the equipment to the soil horizons. The noise generated by the earth moving actions is partially transferred through the soil to surrounding areas, including the adjacent aquatic environment. This is referred to as coupled transmission. A report by Burgess and Blackwell (2003) indicated that vibratory installation of a sheet pile wall in an upland position generated sound levels of approximately 140 dB (re: 1 μPa) at a distance of 200 feet in the adjacent waterway, indicating that the noise was coupled through the soil to the water column. It is expected that the noise transferred through the soil horizons to the adjacent waterways will attenuate in strength relatively quickly. Thus, it is unlikely that the noise level received by the aquatic system will be of sufficient energy to cause mortality or injury, rather, it will more likely result in levels of sound energy that cause harassment or behavioral responses. It is anticipated that the resulting noise levels will initially "drive" fish away from the area affected, however they may return or stay in the area as they acclimate to the new acoustic environment. Still, noise coupled with increased human activity (*i.e.*, motion, noise, shadows, etc.) on the levee may be sufficient to "drive" fish away from the work area for longer periods. Therefore, it is expected that any fish within the areas adjacent to levees under construction will avoid the shoreline and the shallow water adjacent to the levee toe and move into deeper, open water to avoid the noise during construction activities. This has the potential to expose the fish to elevated predation pressures from a lack of access to hiding areas associated with the shoreline.

Construction of the levee modifications are anticipated to last the entire length of time available each year (mid-July through October 31 along the San Joaquin River sections and mid-April through October 31 on the tributaries and slough sections of the Project). This will last the projected 10 years it will take to complete the levee modifications proposed for the Project (2018 through 2028).

Aquatic Construction Sources

The BA describes the construction of two operable flood control gates; one in Smith Canal and the second in Fourteenmile Slough and a flood wall constructed adjacent to the Smith Canal flood control gates. The design of the two gate structures will require that a sheet pile wall be constructed across the width of the site specific waterway and tied into the adjacent levee banks. The sheet pile wall will consist of two parallel walls of sheet pile, approximately 20 feet apart, that will be tied together, braced, and filled with stone aggregate. In the center of the channel, a gate enclosure will be constructed in the sheet pile wall measuring approximately 70-feet by 70-feet which will subsequently be dewatered for the construction of the gate foundation, which includes several 24-inch diameter concrete pilings and a concrete slab floor. The concrete floor will be supported on a grid of 24-inch diameter concrete piles driven into the channel bottom (Corps 2015).

In order to drive the sheet pilings into the channel bottom, two types of pile driving hammers are proposed for the Project. The Corps proposes to use a vibratory hammer to initially drive the sheet piles to the approximate final depth required, then finish the installation of the sheet pile walls with an impact hammer to achieve final tip depth and load bearing strength required in the design specifications. The Corps also anticipates that the landside portions of the sheet pile wall that tie into the adjacent levees will require the use of an impact hammer to achieve the necessary depth and load bearing for these sections. The installation of the 24-inch diameter concrete piles will require that an impact hammer be used to drive them to depth and the load bearing resistance necessary to support the concrete floor foundation upon which the steel gate structure will be mounted. The Project's description in the BA indicates that each half of the channel will take one construction season to complete with pile driving occurring over a 2-month period. The installation of the sheet pile cofferdam surrounding the gate location will take approximately 3 weeks to install. The cofferdam will close off the area of the gate structure, allowing the workspace behind it to be dewatered. Following the installation and dewatering of the work area, concrete pilings will be driven into the exposed work area to support the floor of the gate foundation and the gate structure. Construction of the foundation and gate will take an additional 6 months. Complete construction of the sheet pile wall and operable gates will take approximately 2 years to complete, requiring pile driving actions for the two work seasons.

Sheet piles and the concrete pilings are driven into the substrate until a predetermined level of resistance is encountered by the hammer. This typically is measured as the number of hammer blows required to move the sheet pile (or concrete pile) a certain distance into the substrate (*e.g.* number of blows to move 1 foot in depth). Energy transferred to the pile by the hammer is partially redirected as acoustic energy and heat as the pile loses energy to the surrounding medium (*i.e.,* soil or rock). As sound propagates away from the source, several factors change its amplitude (Burgess and Blackwell 2003). These factors include the spreading of the sound wave over a wider area (spreading loss), losses to friction between water or sediment particles that vibrate with the passing sound wave (absorption), scattering and reflections from boundaries and objects in the sound's path and constructive and destructive interference with one or more reflections of the sound off "solid" surfaces such as the seafloor or water surface. The sound level measured at any given point along the path of the propagated sound wave includes all of these effects and is termed the received level. The sum of all of the propagation and loss effects on a signal is called the transmission loss and is the difference between the received level and the source level. The effects of this sound transmission are described in the following section on *Effects of sound on fish.*

The construction project location at Smith Canal has several factors which may alter the transmission of the propagated sound waves into the channel of the San Joaquin River during the pile driving activities. The channel width to Rough and Ready Island directly across the San Joaquin River from the Smith Canal gate location is approximately 500 to 800 feet in a direct line. The propagation of sound could continue up and down river from the construction site for 2 to 3 thousand feet, based on a straight line of sight from the gate structure and the configuration of the northern shoreline and levees. The channel depth varies over a wide range in the reach adjacent to the construction project site. Along the levee banks, the depth is only 9 feet deep (mean low water) and a shallow bench exists that extends out from the levee toe to the dredged ship channel. The dredged ship channel, which is approximately 35 feet in depth at low tide, passes to the south of the construction project site and drops off rapidly from the shallow bench. To the east of the gate alignment, the shallow bench continues into Smith Canal. These changes in bottom contours will create conditions that will attenuate the propagation of sound through the channel (null spots). In addition, ambient noise from river flow, boat traffic, and irregular surfaces such as the rip rapped surface of the levees may create additional acoustic signals that muffle or cancel out the acoustic signal from the pile driving actions (masking). Installation of the concrete support pilings for the gate structure is anticipated to take place in the dewatered work area behind the coffer dam. The acoustic noise derived from the pile driving of the concrete support piles is expected to primarily be propagated through the soil to the aquatic environment (coupled transmission), rather than through the air. The construction project location on Fourteenmile Slough has a more confined and uniform channel geometry. The channel is approximately 300 feet wide with an average depth of approximately 8 feet. The section of channel in which the gate will be located is fairly straight for about 1,300 to 1,500 feet in either direction along the alignment of the slough before the channel begins to bend. The specific impacts are described in the following section *Effects of sound on fish*.

Effects of sound on fish

The installation of sheet piles and concrete piles with either a vibratory pile driving hammer or impact hammer is expected to result in adverse effects to listed salmonids and green sturgeon due to high levels of underwater sound that will be produced. Although adverse effects to fish from elevated levels of underwater sound are well documented for explosives (Gaspin 1975, Keevin and Hempen 1997a) and air guns (Pearson *et al.* 1992, Engas *et al.* 1996, McCauley *et al.* 2003, Popper *et al.* 2005), there was initially little information regarding the effects on fish from underwater sound pressure waves generated during the installation of piles (Caltrans 2001, Vagle 2003). Laboratory research on the effects of sound on fish has used a variety of species and sounds (Hastings *et al.* 1996, Popper and Clarke 1976, Scholik and Yan 2002, Turnpenny *et al.* 1994). Experimental data found in the literature concerning the effects of sound on aquatic animals are not reported in a consistent manner, and most of these studies did not examine the type of sound generated by pile driving.

The degree to which an individual fish exposed to underwater sound will be affected (from a startle response to immediate mortality) is dependent on a number of variables such as the species of fish, size of the fish, presence of a swimbladder, sound pressure intensity and frequency, shape of the sound wave (rise time), depth of the water around the pile and the bottom substrate composition and texture. It has long been known that underwater explosives can cause injury and mortality to fish. The Department of the Navy conducted a series of experiments to determine the effects on fish from underwater explosions (Goertner *et al.* 1994, Gaspin 1975) which resulted in significant differences in effects to fish depending on whether or not they had swimbladders. Thus, it is the swimbladder, inflated with gas, which rapidly compresses under the overpressure wave and then expands as the pressure wave passes through the fish and is replaced by the underpressure wave that likely causes the observed injuries to internal organs (Keevin and Hempen 1997a). An important characteristic of the underwater sound that causes injury is the frequency. During pile installation, most energy is contained within the frequency range (100–1,000 Hertz) which results in reverberation of the swimbladder. Studies have shown that the most susceptible tissues that are injured during exposure to underwater sound produced from pile driving are the soft-tissue organs surrounding the swimbladder, such as the liver and kidney (Caltrans 2001, Abbott and Bing-Sawyer 2002, Caltrans 2003).

There are two types of swimbladders: physostomous, in which the organ is thin, membranous and connects to the esophagus through a pneumatic duct, and physoclistous, in which the organ is thick-walled and connected to the blood stream (Smith 1982). Both salmonids and sturgeon possess physostomous swimbladders (Smith 1982). As indicated by Keevin and Hempen (1997b) fish with physoclistous swimbladders are believed to be most sensitive to blast pressures, however, species with either type of swimbladder are more susceptible to injury than fish which lack swimbladders. In addition, sturgeon, which are considered to be primarily benthically oriented fish, are known to have large swimbladders (Nelson 1994). Large swim bladders make green sturgeon more susceptible to acoustic impacts than fish with smaller swimbladders.

Although underwater sound pressure waves generated during pile driving are different in several ways from those generated during explosions, the mechanism of injury (*i.e.*, swimbladder expansion) may be similar. The most important differences between the two are the repetitive nature of pile driving and the overpressure-underpressure oscillations within the pile driving signal. When fish are exposed to multiple strikes, the repetitive oscillations and the resultant pressure waves will cause the swimbladder to act like a drum, and although any single pulse (depending on its magnitude) may not result in acute injury to the internal organs, the repetitive nature of the sound produced during pile driving is likely to result in injury due to the repetitive flexure of the organ membrane, particularly if the membrane experiences resonance.

NMFS uses the sound exposure level (SEL) metric, expressed as the square of the time integrated sound-pressure-level measured in decibels over the duration of the sound exposure (decibels are referenced to one micropascal (μPa) of pressure; one pascal is equivalent to 1 Newton of force per square meter[2]), to correlate physical injury to fish from underwater sound pressure produced during the installation of piles (Hastings and Popper 2005). This metric allows for the summation of energy over multiple pulses (strikes). Using SEL, the exposure of fish to a total amount of energy (*i.e.,* dose) can be used to determine a physical injury response.

NMFS must make some assumptions as to the behavior of the fish and the recovery time of tissue being affected in order to determine the response (*i.e.*, avoidance, injury, death) of the fish. Sonalysts (1997) suggested that although fish (including Atlantic salmon) exhibit a startle response during the first few acoustic exposures, they do not move away from areas of very loud underwater sounds and can be expected to remain in the area unless they are carried away by currents or normal movement patterns. Therefore, NMFS will assume that fish will remain in the vicinity of a construction site unless currents or behavior patterns unrelated to loud underwater sound avoidance would indicate that salmonid movement is likely to occur. Although there may be some tissue recovery between the completion of one pile and the

[2] In the remainder of this document, SELs are referenced to one micropascal squared-second.

beginning of pile driving at the next, given the level of uncertainty that exists, NMFS will sum the underwater sound energy produced during the installation of all piles on any given day to determine potential physical effects to listed salmonids and sturgeon. NMFS will assume that normal behavior patterns will move migrating salmonids and green sturgeon out of the affected area within one day, and therefore underwater sound energy will not be summed across separate days. This would not be the case if the construction site were located in an area where either adult salmonids or sturgeon were spawning or juveniles were rearing for extended periods of time in the action area.

The structure of the fish inner ear is similar to that of other vertebrates: each ear has three semicircular canals and three otolithic organs, the utricle, saccule, and lagena. The semicircular canals and otolithic chambers are interconnected and filled with endolymphatic fluid. The swimbladder may act somewhat as an eardrum by responding to the sound pressure waves, depending on the species of fish. The motion of the swimbladder radiates a secondary signal to the inner ear. This provides the necessary particle movement for otolithic/auditory nervous stimulation, especially in species having the shortest distance between the swimbladder and the auditory apparatus (pars inferior).

The literature indicates damage to hearing by intense sound depends on auditory threshold and will vary from species to species (Popper and Fay 1973). Damage to hearing is normally measured in sound pressure levels expressed as root mean squared (RMS) decibels re 1 micropascal[3]. Some fish have hearing thresholds as low as 50 decibels RMS (dB_{rms}) while others have thresholds as high as 150 dB_{rms}. Enger (1981) exposed 26 Atlantic cod (*Gadus morhua*) to continuous tones of 180 dB_{rms} at frequencies from 50 to 400 Hertz (Hz) for one to five hours and found destruction of auditory hair cells in the saccule. The cod has a hearing threshold of 75-80 dB_{rms} between 100 and 200 Hz (Chapman and Hawkins 1973), so 180 dB_{rms} is about 100 dB above threshold. For Atlantic salmon (*Salmo salar*), Hawkins and Johnstone (1978) reported best sensitivity of 95-100 dB_{rms} between 100 and 200 Hz. Since the 100-200 Hz is the bandwidth of best sensitivity for both cod and Atlantic salmon, Hastings (2002), in support of the Caltrans BA of the Benicia-Martinez New Bridge Project, stated she would expect to see damage of auditory hair cells in salmon occurring with exposure to continuous sound at about 200 dB_{rms}. The peak pressure associated with a continuous sound of 200 dB_{rms} is equivalent to 203 dB_{peak}, thus Hastings (2002) concludes hearing damage to the sensory hearing cells of salmon onsets at a sound level of 203 dB_{peak}.

Hastings (1995) found destruction of auditory sensory cells when she and her colleagues exposed goldfish (*Carassius auratus*) to continuous tones of 189, 192, and 204 dB_{peak} at 250 Hz and 197 dB_{peak} at 500 Hz for approximately two hours. Four fish were exposed to each set of conditions and destruction of ciliary bundles was found to correlate with sound pressure level at a 95 percent confidence level. Hastings *et al.* (1996) also found destruction of sensory cells in the inner ear of oscars (*Astronautus ocellatus*) four days after being exposed to continuous sound for one hour to 180 dB_{peak} at 300 Hz. The authors found no damage in fish allowed to survive for only one day after exposure, suggesting that damage may develop slowly in the sensory cells of

[3] In the remainder of this document, rms pressure levels are referenced to one micropascal.

the fish's inner ears. NMFS is not aware of any similar studies conducted with green sturgeon or salmonids, however, the impacts are assumed to be similar given the relative similarity of the anatomical structure of the inner ear within fish species.

Sonalysts (1997) reported that they performed reaction testing with caged Atlantic salmon at a wide range of sound pressure levels and frequencies. They stated that although some avoidance was noted at certain specific levels and frequencies, no avoidance response was seen when the sound pressure levels (likely RMS) were over 180 decibels (dB). The report also included a brief discussion of previously unreported studies that show that beyond a brief startle response associated with the first few acoustic exposures, fish do not move away from areas of very loud noises and are expected to remain in the area unless they are carried away by currents.

To determine the level of underwater sound that would elicit a behavioral response, Turnpenny *et al.* (1994) exposed a variety of fish species to varying levels of sound and frequency. No significant avoidance was found for trout at exposure levels (metric not specified) of up to 150 dB, although a reaction threshold of around 170 dB was observed. The authors used pure tone bursts, which cause an effect at a lower sound pressure level due to the higher duty cycle of the signal.

In the early 1990s, pile driving operations in Puget Sound were reported to disrupt juvenile salmon behavior (Feist 1991, Feist *et a*l. 1992). Though no underwater sound measurements are available from that study, comparisons between juvenile salmon schooling behavior in areas subjected to pile driving/construction and other areas where there was no pile driving/construction indicate that there were fewer schools of fish in the pile-driving areas than in the non-pile driving areas. The results were not conclusive, but suggest that pile-driving operations may result in a disruption in normal migratory behavior.

During the construction of the Benicia-Martinez Bridge Project in April 2002, observations were made during pile driving that suggest small fish subject to the exposure of elevated underwater sound pressure levels can be vulnerable to predation. The stomach of a piscivorous striped bass killed by high underwater sound pressure levels was examined and found to contain several freshly consumed juvenile herring (R. Blizard, Caltrans, pers. comm. May 2002 to D. Woodbury, NMFS). Although necropsies were not performed on the juvenile herring (*Clupea harengus*), the consensus of the biologists present at the site was that the striped bass were feeding heavily on killed, injured, or stunned herring prior to swimming into the zone of lethal sound pressure levels themselves.

It appears that physical damage to the auditory system of salmonids is likely to occur at levels at or above 200 dB_{rms}, which is near the SEL threshold at which physical injury to the organs adjacent to a fish's swimbladder is estimated to occur. A white paper written by Popper *et al.* (2006) proposes a dual metric approach, incorporating both SEL and peak pressure, in assessing potential physical injuries to fish from exposure to elevated levels of underwater sound produced during pile driving. The authors proposed interim single strike thresholds of 187 dB SEL and 208 dB peak. In a critique of the white paper, a NMFS scientist from the Northwest Fisheries Science Center in Seattle, Washington (Memorandum to Mr. Russ Strach and Mr. Mike Crouse, NMFS from Tracy Collier, NMFS, September 19, 2006) stated that exposure to multiple strikes must be considered in assessing impacts. They further stated that the method described in Hastings and Popper (2005) is appropriate. Specifically, to account for exposure to multiple impulses (strikes), the single strike SEL at a given distance from the pile is added to 10*log (number of strikes) to give a cumulative SEL. Thus, using the parameters set forth in the papers referenced above, an accumulated 187 dB_{SEL} is used to estimate the onset of physical injury to small fish. Given that larger fish can tolerate a larger dose before eliciting a similar response (Yelverton *et. al.*1975), 3 decibels are added to this threshold to obtain a threshold of 190 dB_{SEL} for adult salmonids and sturgeon. In response to this new information, an interagency working group, which included staff from NMFS, established interim criteria for evaluating underwater noise impacts from pile driving on fish. These criteria are defined in the document entitled "Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities" dated June 12, 2008 (Fisheries Hydroacoustic Working Group 2008). This agreement identifies a peak sound pressure level of 206 decibels (dB) and an accumulated sound exposure level (SEL)[4] of 187 dB as thresholds for injury to fish. For fish less than 2 g, the accumulated SEL threshold is reduced to 183 dB. Although there has been no formal agreement on a "behavioral" threshold, NMFS uses 150 dB_{RMS} as the threshold for adverse behavioral effects (NMFS 2009).

Pile driving under the proposed Project also would include work done with a vibratory pile driver. Vibratory pile driving is accomplished by attaching a variable eccentric vibrator to the head of the pile to drive the pile into the substrate. The interim criteria for sound injury thresholds for fish were established specifically for impact pile driving and were not intended to be applied to vibratory driving. However, for this assessment the interim criteria will be evaluated along with new criteria that have been recently published for vibratory driving (Hastings 2010). The recently proposed criteria for vibratory pile driving were based on findings that higher threshold levels specifically related to the effects caused by vibratory pile driving hammers are warranted (Hastings 2010). These preliminary criteria are:

Non-auditory tissue damage

Mass $\leq$ 0.6 g = 191 dB-$SEL_{accumulated}$
For fish between 0.6 and 102 g mass, cumulative SEL = 195.28 + 19.28*log10(mass)
Mass $\geq$ 102 g = 234 db-$SEL_{accumulated}$

Auditory tissue damage

Hearing generalists (e.g., salmonids): > 234 dB-$SEL_{accumulated}$
Hearing specialists (e.g., carp): 222 dB-$SEL_{accumulated}$

Temporary threshold shift (hearing loss)

Hearing generalists: 234 dB-$SEL_{accumulated}$
Hearing specialists: 185 dB-$SEL_{accumulated}$

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[4] Sound exposure level (SEL) is defined as the constant sound level acting for one second, which has the same amount of acoustic energy as the original sound. Expressed another way, the sound exposure level is a measure of the sound energy in a single pile driver strike. Accumulated SEL (SEL accumulated) is the cumulative SEL resulting from successive pile strikes. $SEL_{accumulated}$ is based on the number of pile strikes and the SEL per strike; the assumption is made that all pile strikes are of the same SEL.

Preliminary pile driving noise modeling will be conducted with the NMFS Underwater Noise Calculation Spreadsheet model (NMFS 2009) and available data. NMFS made several assumptions based on previous consultations to fill in information gaps when data is needed to run the model. When specific detailed engineering designs are developed for the Project during the PED phase, a more detailed modeling exercise will be conducted. The Compendium of Pile Driving Sound Data (California Department of Transportation 2007) provides sound level data on a variety of pile sizes and driver types and this information will be incorporated into the analyses of sound exposure during this consultation and the ensuing PED phase to ensure protection of exposed fish in the action area. In keeping with the generalized overview of Project effects necessary for this consultation, absent specific detailed actions that will be developed later in the PED phase, NMFS anticipates that all impact pile driving actions undertaken for the installation of sheet piles and concrete pilings will negatively affect fish present within the San Joaquin River channel or the Fourteenmile Slough channel during pile driving actions.

NMFS has constructed a generalized assessment of the pile driving impacts based on the information provided in the LSJRFS BA (Corps 2015). Although this information is not detailed enough to complete a full analysis, it will provide a simplified level of effects that will be useful in determining incidental take. The BA states that the Smith Canal gate structure will have a wall 800 feet long wall between the end of Dad's Point on the southeast side of the structure and the levee to the northwest. The wall is comprised of two parallel sheet pile walls, thus a total of 1600 feet of sheet piles will be needed to complete the structure. In addition, the two sides of the gate enclosure, which measures 70-feet by 70-feet, and are perpendicular to the wall alignment, will add an additional 140 feet of sheet piles (2 x 70 feet). The total length of sheet pile walls is approximately 1,740 feet. Each sheet pile is typically 2 feet wide (from the compendium of pile driving sound data) which means that approximately 870 piles are needed for the Smith Canal structure. The BA states that the Project will be divided into two years' worth of work, thus roughly 435 piles will be installed each year for the Smith Canal installation. The BA states that installation of the sheet pile wall will take 2 months each work season (42 work days not including weekends; 5 days per week x 8 weeks = 40 days (16 days of weekends) and 2 more work days to round out the two months (60 days total). Based on information provided in the compendium, a sheet pile wall installed at the Port of Oakland took 5 to 18 minutes per sheet pile section to drive to depth using the vibratory hammer. NMFS used an average value of 12 minutes to represent the typical pile. NMFS also assumed that roughly 10 piles will be driven each day based on previous consultations.

In the absence of site-specific data, NMFS recommends using an underwater attenuation rate of 4.5 dB per doubling of distance (NMFS 2009). It also supports the notion that sound levels of less than 150 dB do not contribute to the accumulated SEL for the purposes of assessing injury (NMFS 2009). NMFS calculated the total time for pile driving each day using the assumptions that it takes 12 minutes of pile driving at each sheet pile section and 10 piles per day, (12 minutes/pile * 60 seconds/minute*10 piles per day= 7,200 seconds total pile driving time per day, assuming 1 strike per second). NMFS then calculated the sound exposure for driving the sheet piles with a vibratory hammer using the spreadsheet calculator with the assumed attenuation rates and the following values for the 2 foot wide sheet piles based on the compendium.

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using a Vibratory Driver/Extractor

Material	Peak	RMS	SEL(for 1 second of vibratory driving)
24- inch AZ Steel sheet	177 dB	163 dB	162 dB

For the period of time that the sheet piles are driven during the day (7,200 seconds) the calculated distances to the different sound level parameters are shown below.
The $SEL_{accumulated}$ is 201.6 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = less than 1 meter (less than 3.3 feet)
Distance to 150 dB-RMS = 74 meters/ 245 feet
Distance to 187 dB-$SEL_{accumulated}$ = 63 meters/ 207 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 63 meters/ 207 feet (for fish < 2 g)

Using the criteria for vibratory hammers as proposed by Hastings (2010), NMFS finds the following risks. For the smallest fish (≤ 0.6 g), the distance to the 191 dB-$SEL_{accumulated}$ threshold for non-auditory tissue damage would be less than the distance calculated for the 187 dB-$SEL_{accumulated}$ threshold (i.e., 207 feet or 63 meters). However, juvenile salmonids and juvenile green sturgeon in the study area would be expected to be larger than 0.6 grams. Assuming a fish weight of 10 grams, the distance to the appropriate threshold for non-auditory tissue damage (i.e., 195.28 + 19.28*log10 (10 grams) = 215 dB-$SEL_{accumulated}$) would be much less than 1 meter. Most juvenile salmonids and green sturgeon in the Project area would be expected to be larger than 10 grams, thus they would have to be at the point source of the pile driving activities to sustain injury to non-auditory tissues. In addition, since the sound generated by the vibratory pile driving is less than 206 dB at 1 meter, the threshold for auditory tissue damage and hearing threshold shifts (greater than 234 dB required) would never be exceeded. Lastly, it is not expected that the exposed fish would remain in the same location over the entire day to experience the full duration of the pile driving due to river currents, tides, and behavioral movements.

Next, NMFS calculated the exposure distances for driving the sheet piles with the impact hammer to the final tip depth and load bearing criteria. NMFS calculated the total time for pile driving each day using the assumptions that it takes 5 minutes of pile driving (based on data from the compendium) at each sheet pile section and 10 piles per day, (5 minutes/pile * 60 seconds/minute*10 piles per day= 3,000 seconds total pile driving time per day, assuming 1 strike per second). NMFS calculated the sound exposure for driving the sheet piles with an impact hammer and the NMFS calculator using the following values for the 2 foot wide sheet piles based on the compendium;

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using an impact hammer.

Material	Peak	RMS	SEL (for 1 second of pile driving)
24- inch AZ Steel sheet	205 dB	190 dB	180 dB

For the period of time that the sheet piles are driven during the day (3,000 seconds) with the impact hammer, the calculated distances to the different parameters are as follows:
The $SEL_{accumulated}$ is 215 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = 9 meter (less than 29.5 feet)
Distance to 150 dB-RMS = 4642 meters/ 15,230 feet
Distance to 187 dB-$SEL_{accumulated}$ = 710 meters/ 2,329 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 1000 meters/ 3,281 feet (for fish < 2 g)

Based on these calculations, there is potential for behavioral modifications to fish that remain within a 4,642 meter radius of the sheet pile being driven during installation of the sheet pile wall (10 per day). There is the potential to exceed the threshold for physical injury if fish larger than 2 grams remain within a 710 meter radius of the pile driving actions (187 dB $SEL_{accumulated}$) or 1,000 meters if fish are smaller than 2 grams (183dB $SEL_{accumulated}$). This would create a zone that would cover the entire channel width of the San Joaquin River and for fish larger than 2 grams extend approximately 2,300 feet upstream and downstream from the location of the gate and flood wall installation during the construction activities. Any fish swimming through this reach during the impact hammer use would likely suffer some degree of injury and potentially mortality.

The construction of the flood gate's platform requires the installation of 24-inch diameter concrete pilings to a final tip depth and load bearing resistance with the impact pile driving hammer. Using the same methodology as described for the sheet piles, NMFS will use the spreadsheet calculator to determine the distances to the different injury thresholds. NMFS assumes that each pile will take approximately 20 minutes to drive and that 5 piles will be done each day. NMFS calculated the total time for pile driving each day using the assumptions that it takes 20 minutes of pile driving at each pile location and 5 piles per day, and 1 second between hammer strikes (20 minutes/pile * 60 seconds/minute*5 piles per day)= 6,000 seconds total pile driving time per day, assuming 1 strike per second). NMFS calculated the sound exposure for driving the sheet piles with an impact hammer and the NMFS calculator using the following values for the 24-inch concrete piles based on the compendium.

(10-Meter) Unattenuated Sound Pressure Levels for In-Water Installation Using an impact hammer.

Material	Peak	RMS	SEL (for 1 second of pile driving)
24- inch concrete pile	185 dB	170 dB	160 dB

For the period of time that the concrete piles are driven during the day (6,000 seconds) with the impact hammer, the calculated distances to the different parameters are as follows:
The $SEL_{accumulated}$ is 198 dB at 10 meters (33 feet) and the calculated distance to each of the applicable thresholds is as follows:

Distance to 206 dB-peak = less than 1 meter (3.3 feet)
Distance to 150 dB-RMS = 215 meters/ 705 feet
Distance to 187 dB-$SEL_{accumulated}$ = 46 meters/ 151 feet (for fish > 2 g)
Distance to 183 dB-$SEL_{accumulated}$ = 46 meters/ 151 feet (for fish < 2 g)

Based on these calculations, there is potential for behavioral modifications to fish that remain within a 215 meter radius of the piles being driven during installation of the gate foundation (assuming 5 piles per day). There is the potential to exceed the threshold for physical injury if fish remain within a 46 meter radius of the pile driving actions (187 dB $SEL_{accumulated}$ for fish larger than 2 grams or 46 meters if fish are smaller than 2 grams (183dB $SEL_{accumulated}$). This would create a zone that would cover 20 to 30 percent of the channel width of the San Joaquin River and extend approximately 150 feet upstream and downstream from the location of the gate and flood wall installation during the construction activities. Any fish swimming through this reach during the impact hammer use would likely suffer some degree of injury and potentially mortality. These are conservative estimates as the Corps intends to drive the piles behind the cofferdam in the dry. Noise will mainly be transferred through the sediment horizon and not through the water, due to the air surrounding the pile being driven. All of these factors will reduce the zone in which fish may be injured or killed.

Using the same assumptions as used for the Smith Canal structure, the sound effects related to the installation of the gate structure in Fourteenmile Slough will result in essentially the complete blockage of the channel at the location of the structure. The channel is only 300 feet wide, and even with the lower intensity of the vibratory hammer for sound generation, the radius of sound that exceeds the thresholds for behavioral modifications is 245 feet. This would cover approximately all of the channel when pile driving is next to the shore and the whole channel when construction is occurring in mid-channel. The use of the impact hammer to finish driving the sheet piles would create an extensive area in which injury or mortality could occur, approximately a zone with a radius of 2,300 feet that extends up and down the channel through which no fish could avoid injury. When the concrete piles are being installed, the coverage will extend across the complete channel as the installation occurs in the middle of the channel and the radius of effects is approximately 151 feet.

2. Turbidity Related Effects

The Corps has stated that the Project will have a 10 year life span starting in 2018 and ending in 2028. Different project sites within the action area will be undergoing construction actions during this period of time. During the clearing and grubbing phases of the construction actions at each of the proposed sites, all vegetation will be removed from the top 75 percent of the levee's waterside face and 100 percent of the landside face. The actions will leave the soil exposed and disturbed for the future construction activities to take place. However, this condition accelerates the potential for erosion from any precipitation events that may occur during construction or after the construction work window has ended without proper erosion management practices. The Corps has stated in their BA that they will implement erosion control measures (standard construction BMPs), including a Storm Water Pollution Prevention Program and a Water Pollution Control Program that are designed to minimize soil or sediment from entering the river, sloughs, or adjacent waterbodies during construction activities. However, post-construction and off-season controls were not explicitly described in the BA, and NMFS must assume that monitoring and maintenance of the BMPs during these periods may not be as rigorous as during the active construction seasons of the Project. Furthermore, the Corps has stated that all exposed levee slopes will be hydroseeded in an attempt to revegetate the exposed slopes with native grasses and forbs. This action would aid in preventing erosion from occurring and soils entering the adjacent waterways, but no monitoring plans to determine the success of this action are described in the BA. Therefore NMFS must assume that some of these actions will not be successful and erosion will occur on a portion of the slopes exposed by construction activities and which have had failures of the hydroseeding practices to establish a cover of vegetation.

During the installation of the sheet pile walls used in the construction of the two flood gate structures, NMFS anticipates that sediments from the bottom of the waterway channels will be disturbed by the construction activities and resuspended into the overlying water column. This will create localized turbidity plumes. Construction activities for these two structures will take several years. The Smith Canal structure is anticipated to take two years for completion, with the majority of the work occurring over the two summer work windows. The flood gate structure on Fourteenmile Slough is similar in construction design with a narrower channel width requiring a shorter sheet pile wall. However, it will also take approximately two summer work windows to complete due to the necessity of maintaining navigable waters during construction. During these periods, NMFS anticipates that construction related turbidity events will occur as a direct effect of the Project's actions.

During the long term period of gate operations, the narrow gate opening (~50 feet) will create a higher velocity flow through the structure than currently exist through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

Effects of turbidity on fish and aquatic habitat

Suspended sediments can adversely affect salmonids in the area by clogging sensitive gill structures (Nightingale and Simenstad 2001) but are generally confined to turbidity levels in excess of 4,000 mg/L. Based on the best available information, NMFS does not anticipate that turbidity levels associated with the erosion from levee waterside faces in the Project action area or the sheet pile installation itself will increase to these deleterious levels. However, responses of salmonids to elevated levels of suspended sediments often fall into three major categories: physiological effects, behavioral effects, and habitat effects (Bash *et al.* 2001). The severity of the effect is a function of concentration and duration (Newcombe and MacDonald 1991, Newcombe and Jensen 1996) so that low concentrations and long exposure periods are frequently as deleterious as short exposures to high concentrations of suspended sediments. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 nephelometric turbidity units [NTUs]) that are expected to result from this Project. Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barret *et al.* 1992). Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton, and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987, Newcombe and MacDonald 1991). These impacts to the aquatic environment decrease the availability of food resources for salmonids and sturgeon through trophic energy transfers from the lowest trophic levels (*i.e.,* phytoplankton and periphyton) through intermediate levels (*e.g.,* invertebrates) to higher trophic levels (*i.e.*, salmonids and sturgeon).

Resuspension of contaminated sediments may have adverse effects upon salmonids or green sturgeon that encounter the sediment plume, even at low turbidity levels. Lipophilic compounds in the fine organic sediment, such as toxic PAHs, can be preferentially absorbed through the lipid membranes of the gill tissue, providing an avenue of exposure to salmonids or green sturgeon experiencing the sediment plume (Newcombe and Jensen 1996). Such exposures to PAHs have been linked with declines in the immune systems of exposed fish as well as damage to genetic material through formation of breaks or adducts on the DNA strands. Similarly, charged particles such as metals (*e.g.*, copper), may interfere with ion exchange channels on sensitive membrane structures like gills or olfactory rosettes. This reduces the sensitivity of fish to detect smells or chemical cues in their environment and may interfere with ion exchange metabolism across cellular membranes necessary for osmoregulation. Increases in ammonia from the sediment may create acutely toxic conditions for salmonids or green sturgeon present in the channel's margins.

Based on the timing of the levee construction and pile driving actions (mid-July through October 31 in the San Joaquin River area), NMFS expects the direct impacts created by these activities to be experienced by adult CCV steelhead migrating upstream to the watersheds of the Calaveras and San Joaquin Rivers, foraging adult green sturgeon, and rearing juvenile green sturgeon.

Although some steelhead smolts may be migrating downstream at this time too, their numbers are expected to be low compared to the peak of migration in spring and would tend to be associated with rain events or pulse flow operations on the tributaries. There is likely to be little exposure to any CV spring-run adults or outmigrating juveniles resulting from the reintroduction efforts based on the expected timing of their life histories. In contrast, levee construction activities on the Calaveras River (mid-April through October 31 as indicated for tributaries and sloughs in the BA) may additionally expose a large proportion of the emigrating CCV steelhead smolts from that tributary to elevated turbidity if there is hydrologic connectivity between the Delta and the upper watershed. There is also some potential in the tide water sections of the Calaveras River for adult and juvenile CV spring run from the reintroduction effort to be exposed to elevated turbidities based on their expected migration periods.

Increased flows in the main channel of the San Joaquin River, as a result of pulse flows or precipitation events in September and October, are expected to ameliorate the negative effects of increased turbidity by shortening the duration of migration through the action area and diluting the resuspended sediments in the water column. Likewise, hydraulic connectivity in the Calaveras River is typically associated with recent large precipitation events and the rainy season in general. Increased turbidity due to rain runoff is expected to be similar to or greater than that generated within the construction area by pile driving activities and levee construction.

Therefore, actions that take place early in the work window on the San Joaquin River (July and August) are expected to have insignificant effects on listed salmonids since the likelihood of their presence in the action area is considered low and the turbidity levels are not expected to reach a level where take occurs. Should in-water work be postponed or started later in the work window (*i.e.*, September or October), then the probability of in-water work overlapping with listed salmonid presence increases and the potential for exposure to elevated turbidity increases. This increases the risk for non-lethal levels of take to exposed fish, although the level of risk is considered to be still quite low.

For the Calaveras River, turbidity during a work window that overlaps with a loss of hydraulic connectivity in the spring (mid-April to June) or the onset of the dry season when the river typically loses it connection between the Delta and the upper watershed, will have insignificant effects on listed salmonids. If listed salmonids are not migrating through the work area due to a loss of a functional migratory corridor related to the lack of hydraulic connectivity, then fish cannot be exposed to the Project's actions in this location and the potential increase in turbidity related to construction activities. Take is not likely to occur since listed salmonids are not likely to be present in the active work area.

The exposure risk to green sturgeon is less clear. It can be anticipated that juvenile green sturgeon could be found year-round in the central Delta, particularly in the deeper sections of the DWSC based on sturgeon behavior and their preference for deep holes in river channels. Presence on the shallower margins of the river is likely to occur at night, when fish are foraging in those areas. Therefore, the elevated turbidity levels created by the sheet pile installation during the daylight construction period may not persist into the night when sturgeon could be anticipated to move into the work area, thus reducing their exposure potential. If fish are not present when the turbidity conditions exist, they are unlikely to incur any demonstrable effects from the turbidity event, thus no take occurs. Based on this behavioral characteristic for nocturnal foraging, the risks are considered negligible to juvenile green sturgeon and the potential for take is extremely unlikely.

2.4.1.2 Effects Related to Long Term Operations of the Flood Control Gates

The Corps described the operations of the flood control gates on Smith Canal and Fourteenmile Sloughs over the long term (Corps 2015). The gates will typically be operated only during extreme high tides and flood events when the water elevation exceeds + 8.0 feet (NAVD 88) in the channels containing the gates, or when operated for maintenance purposes. Generally, extreme high tides and floods associated with the rainy season occur between November 1 and April 30. When operated for forecasted high tides above +8.0 feet, the gates will be closed on the lowest tide prior to the predicted high tide, typically within a 24 hour period. The gates will not be opened until the high tide elevation drops below +8.0 feet, thus allowing any accumulated water behind the gate to flow out. The Corps predicts that the duration of the gate closures for extreme high tides should not last more than 6 to 12 hours per a high tide event. They further state that the closures related to extreme high tides will occur approximately 10 times a month during the months of January and February, and rarely will two extreme tides occur within a 24 hour period. On these rare occasions, the gates may remain closed for more than 24 hours.

These episodes of extreme tides create larger than normal movement of waters in the delta and may stimulate adult fish holding in the Delta to move upstream to spawn. When the gates are operated, any fish moving with the increased tidal activity may enter the waterways behind the gates on prior tides and become trapped by the closed gates. However, fish trapped behind the closed gate would typically be detained for less than 24 hours, and usually only for 6 to 12 hours until the next ebb tide.

Fish trapped behind the gate will have typically short term exposures to the waters behind the gates, and any deleterious water quality issues or predator populations that may exist there. Any fish caught behind the gates cannot leave the area of degraded water quality until the gates are reopened and thus are exposed to any negative conditions existing for the duration of the closure. The short duration of exposure is probably not sufficient to cause direct mortality from any contaminants that might be present, but sublethal effects may start to manifest themselves even with exposures of only a few hours. Both Smith Canal, and Fourteenmile Slough, as well as several waterways draining to the eastern Delta in the action area, are listed under the EPA's 303(d) listing of impaired water bodies in California (State Water Resources Control Board 2010) containing elevated levels of organic materials, pesticides, heavy metals, and pathogens, as well as many other constituents that impair water quality. Furthermore, it is unclear how the physical barriers will affect the level of contaminants in the impacted waterways, but it is likely to degrade water quality over the long run by preventing dilution and muting tidal exchange with the larger Delta. Finally, when fish are trapped behind the gates, they become susceptible to predators that may reside in the waterways behind the gate. Entrapped fish will be exposed to these predators for the duration of the gate closure with a reduced avenue of escape through the narrow gate opening. Fish such as CCV steelhead smolts and juvenile CV spring run Chinook salmon are highly vulnerable to predation by predators such as striped bass (*Morone saxatilis*) or largemouth bass (*Micropterus salmoides*) that may also occupy the waters behind the gates. Adult fish are less likely to be predated upon, unless marine mammals such as California sea lions (*Zalophys californianus*) also are present in the waterways when they are closed off. Sea lions are known to occur within the Stockton DWSC leading to the Port of Stockton and are likely to be present near the Smith Canal gates.

The Corps has indicated that if necessary the gates will be closed for an extended period during flood conditions particularly when they are coupled with high tides. If flood conditions, either by themselves or in combination with high tide events, raise the water elevation to greater than +8.0 feet NAVD 88, the gates will be closed until the water elevation recedes below +8.0 feet. Records show that the high water conditions may last several days. Over the last 20 years, these high water conditions happen on average three times a year, with the high waters lasting from a few days to several weeks. As indicated above, there is the potential for listed fish to be trapped behind the flood control gates when they are closed. Under flood conditions, the longer duration of gate closures will expose fish to longer periods of degraded water quality or predation within the enclosed water bodies. Furthermore flood conditions usually coincide with increased precipitation events that create surface runoff from upland areas. This results in increased storm water flows into waterbodies such as Smith Canal and the sloughs feeding into Fourteenmile Slough. Storm water runoff has the potential to be heavily contaminated with organic materials (which decrease dissolved oxygen content in the water), petroleum products from roadways, heavy metals from roadways, pathogens, and pesticides. Storm water is cited as a source for these contaminants in Smith Canal and the eastern Delta waterways, including Fourteenmile Slough, Mosher Slough, and Fivemile Slough (State Water Resources Control Board 2010). Elevated contaminant loads coupled with longer exposure periods will increase the likelihood of sublethal and lethal effects on exposed fish. Furthermore, increased durations of gate closure will expose any listed fish trapped behind the gates to longer periods of predation risk in those waters.

Periods of high runoff that could trigger longer gate closures usually occur in the winter and spring seasons. This period overlaps with the migrations of adult and juvenile CCV steelhead in the San Joaquin River and Calaveras River basins. Likewise, adult and juvenile CV spring-run Chinook from the experimental population and their future progeny would be migrating through the San Joaquin River adjacent to the Smith Canal flood control gates during the late winter and spring periods. There is also an increased potential for adult green sturgeon to begin movements upstream into the San Joaquin River in response to increased flows in the mainstem of the river and its tributaries. Movements of juvenile green sturgeon in the Delta may also be enhanced by increases in river flows and increased turbidity.

It is uncertain what the risk to the populations of listed fish will be due to entrapment behind the gates. If the gates remain closed for extended periods of time, then no new fish will be exposed to entrapment due to gate operations. However, any individual fish that has been trapped behind the closed gates will be vulnerable to increased mortality with prolonged closures. In contrast, more frequent gate operations expose more individual fish to the effects of the flood control structure, but the duration of their captivity is shorter, and lethal effects are less likely to occur due to exposure to contaminants and predation. Although there is significant risk to any individual fish trapped behind the gates, the risk to the population depends on the proportion of the population moving past the gates at the time the gates are closed and what fraction of that number is actually behind the gates when they are operated. This level of detail is unknown at the moment.

Risks to fish are not limited to being entrapped behind the gates when they are closed. The construction of the flood control gates and the accompanying flood wall create a barrier to the free exchange of water into the Smith Canal and Fourteenmile Slough waterways during the daily tidal cycle. The relatively narrow opening of the gates (50 feet) compared to the widths of the unobstructed channels will create a region of high velocity flows through the gate openings with each tidal change in water surface elevation. This zone will be bi-directional as a result of the changes in tidal elevation; flow will move from the area of higher water elevation to the area of lower water elevation depending on the stage of the tide. On the flood tide, water elevations will be increasing on the outside of the gate structures relative to the inside of the gate structures and water will flow up-channel through the narrow gate opening into the area behind the gates at increasing velocity due to head differentials between the two sides of the gate structure. Flow through the gates will diminish as the two water elevations reach equilibrium at the full high tide portion of the tidal cycle. When the tide changes to ebb, the water inside the flood structure will be higher than the water elevation outside and remain so for a longer period of time due to the gate constriction. The flow will now go in the reverse direction through the gate at high velocities.

The creation of a high velocity stream through the gate opening creates a field of velocity shears and their resulting eddies and turbulence along the boundary between high velocities and low velocities on the down current side of the gate. The region of velocity shears and turbulence creates favorable habitat for predators to hold and feed on prey as the prey moves through the high velocity stream. This is particularly true when the flood structure creates vertical structure for predators to orient to immediately adjacent to the higher velocity flow, and hold station outside the higher velocity flows without physically exerting themselves to remain in the favorable feeding locations. The structure also creates shade and obscures the presence of the predators holding against the vertical sheet pile wall, creating an increased risk of predation for smaller sized fish such as juvenile CV spring-run Chinook salmon and CCV steelhead smolts that are entrained in the fast moving stream of water going through the gate opening. This condition will occur typically four times a day with each change of the tide while the gates are open.

In addition to the creation of the high velocity flows through the gate openings and increased predation risks, the flood gate structures also are likely to degrade water quality conditions inside the waterways they "protect". The presence of the gates will reduce the free exchange of water within the waterways they block with the larger Delta system. This will reduce the volume of water exchanged on each tidal cycle with the larger Delta water volume and increase the residence time of the water behind the gate structures and flood wall. This situation is likely to allow contaminants behind the flood structure to increase in concentration since they are not being flushed out of the system as fast as the pre-gate conditions allowed. Finally, without appropriate modeling, NMFS cannot predict what the magnitude of the water quality changes will be, however the changes are expected to occur under all water elevations, and be exacerbated when the gates are closed.

In summary, the long term operations of the flood control gates on Fourteenmile Slough and Smith Canal will create barriers to the free movement of individual fish moving within close proximity to the gates and which are subsequently entrained through the flood control gates. Listed fish that enter through the narrow gate opening will be subject to increased predation risk and exposure to degraded water quality conditions; both conditions are regarded as take. The gate structures will also create physical conditions that decrease the value of the habitat adjacent to these structures. Diminished circulation will decrease flushing flows through these waterbodies, potentially allowing any contaminants discharged into the waterbody behind the structures to increase in concentration and not be transported away from the confined waterbodies. The narrow gate opening will create hydraulic conditions that will favor predatory fish, which will be attracted to the open water structure created by the flood barrier. Both of these physical conditions will increase the level of take of any listed fish exposed to them. These conditions will be present at all water elevations to some extent as described above.

2.4.1.3 Long Term Effects of Levees, Loss of Riparian Habitat, and Vegetation Management under the ETL

The Project perpetuates the presence of miles of engineered levees in the action area to ensure the protection of surrounding urban areas and agricultural lands from flooding. The Corps estimates in their BA that the total amount of horizontal flood features, including the flood control structures is approximately 24.5 miles. The Corps has stated that the preservation of the levee system is non-discretionary in their BA. The Corps has also estimated that approximately 20,000 lineal feet out of 25,000 lineal feet of SRA present in the Project action area will be lost on the lower waterside levee banks, as well as approximately 9 acres of riparian woody vegetation (see Table 7) due to Project's discretionary actions of vegetation removal.

The construction of levees to protect against flooding has significantly altered the environment of the eastern Delta, the east side tributaries that feed into the Delta, and the Calaveras and San Joaquin rivers. Levees replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs in the Delta that provided a spectrum of habitat complexities. Shallow water habitats had a broad range of depths and water velocities present due to the presence of shallow water and riparian vegetation, fallen trees and woody materials (*i.e.*, IWM) that existed on their banks, and the ability of the river to migrate across the floodplain to create additional complexity in the geometry of the river's cross section. Native fish species, including listed salmonids and green sturgeon, evolved under these environmental conditions. In addition, naturally flowing rivers were able to construct riverside benches and naturally formed levees during flood events. These benches could be up to 20 feet high and extended for considerable distances inland creating suitable conditions for the establishment and successional development of structurally diverse riparian vegetation communities (The Bay Institute 1998). Large, continuous corridors of riparian forests and vegetation were present along major and minor rivers and streams in the Central Valley and the Delta periphery. Non-tidal freshwater emergent marshes were present throughout the action area, giving way to tidal freshwater emergent marshes in the primary zone of the Delta (Whipple et al. 2012).

The construction of levees and the "reclamation" of the flood plains and Delta islands eliminated these riparian areas. Only remnant riparian forests and fringing tidal and non-tidal freshwater marshes exist in the action area today. Many of the levees are extensively riprapped with stone armoring on the waterside of the levee and are devoid of any significant vegetation, with the exception of non-native weeds and plants. Only in a few areas where a waterside bench exists outside of the levee toe and vegetation is allowed to grow, does naturally established riparian vegetation grow. These stands of riparian vegetation are discontinuous and frequently very narrow in width, providing a fraction of the ecological benefits of their historical predecessors. In addition to the loss of riparian vegetation, riprapping of levees creates other environmental alterations. The effects of riprapping (USFWS 2000) on riverine processes has been shown to:

- Halt new accretion of point bars and other depositional areas where new riparian vegetation or marsh plants can colonize.
- Arrest meander migration which over time reduces habitat renewal, diversity, and complexity.
- Incise the thalweg of the river adjacent to the armored areas while narrowing the low flow channel width.
- Create relatively smooth, hydraulically efficient surfaces along the riprapped section of levee, which is contrary to the habitat requirements of native fishes, including salmonids and green sturgeon, for hydrodynamic complexity.
- Fill in sloughs, tributary channels, and oxbow lake areas, causing loss of nearby wetland habitat and diversity.
- Limit lateral mobility of the channel, thus decreasing general habitat complexity of the nearshore aquatic area, and reducing complex lateral habitats, including small back waters and eddies which reduces important refugia for numerous species of plants, invertebrates, fish, birds, and mammals.
- Decrease nearshore roughness, causing stream power (*i.e.*, velocities) to increase more rapidly with increasing discharge, thus often eliminating refugia areas for fish and aquatic organisms during high flows and causing accelerated erosion at the downstream interface between the riprapped section and adjacent earthen sections.
- Halt erosion and reduce habitat complexity, thus reducing the ability of near shore areas to retain sediments and organic materials, including IWM. Critical stream refugia areas are also lost due to the isolation of the river from its watershed, primarily by uncoupling the biotic and hydrologic interactions between the stream and the riparian zone.
- Impede plant growth through the thick rock layer at the waterline, which results in vegetation establishing itself farther back from the shoreline, thus reducing the contribution of allochthonous food resources for aquatic invertebrates.
- Halt erosion, which stops woody vegetation from falling into the river, thus causing a long term reduction in the recruitment of new IWM to the system, which results in a wide range of negative effects.

- Halt the retention of IWM that becomes lodged on the riprapped bank during high flows thus preventing the long term retention of such IWM and the habitat they provide.

The intent of riprap is to stabilize stream channels and limit natural fluvial processes. The reduction of the erosion and consequent deposition cycle, naturally inherent to all alluvial channels, eliminates a channel's ability to maintain bedforms for salmonid habitat and impairs the ability for a stream to be maintained in a dynamic steady state. This alteration of the aquatic ecosystem has diverse deleterious effects on aquatic communities, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling *et al.* 2001). Riprap does not provide the intricate habitat requirements for multiple age classes or species similar to natural banks, or banks that include IWM (Peters *et al.* 1998).

Loss of IWM negatively impacts salmonids through multiple phases of their life history. Schaffter *et al.* (1983) showed that juvenile Chinook salmon densities along riprapped banks are one third that of natural banks with the presence of fallen trees and their root balls in the water. They concluded that traditional riprap methods of protection will likely cause decreases in the salmon numbers in the Sacramento River basin. USFWS (2000) reported that in studies conducted in the Sacramento River near the Butte Basin, the highest number of juvenile Chinook salmon were associated with the nearshore areas with woody material, sloping banks, and moderate velocities. Juvenile Chinook salmon catches (measured as catch per unit effort or "CPU") were consistently lowest at riprapped sites and highest at natural bank sites (areas with overhead cover and instream woody cover) and intermediate in areas where experimental mitigation studies with artificially placed IWM. USFWS (2000) reported that additional studies conducted between Chico Landing and Red Bluff on the Sacramento River confirmed the low value of riprapped banks, the high value of natural banks with varying degrees of instream and overhead woody cover, and the intermediate value of mitigated sites.

In large mainstem streams and rivers such as the Sacramento and San Joaquin rivers, the primary benefit of IWM is to the channel margins. The woody materials act to deflect and break up stream flow, creating small eddies, pools, undercut banks, variability in channel depth, and back water areas conducive to rearing and growth (Murphy and Meehan 1991, Bisson *et al.* 1987). Sediment that is trapped by the woody material and stored along the channel margins contributes to the hydraulic and biologic complexity of the stream reach, particularly where organically rich materials are present (Bisson *et al.* 1987). These storage areas create new habitat complexity by trapping inorganic material that creates bars and holes and organic materials that contribute energy and carbon to the local food web of the stream reach (Murphy and Meehan 1991, Bisson *et al.* 1987). These breaks in the river flow also create beneficial holding areas with plentiful food resources and the conditions where salmonids can hold with minimal energy expenditure and feed while rearing. These areas are also beneficial to a wide range of other species native to the system. Such refuges are critically important to the lower river reaches where levee construction and riprapping have disconnected the rivers from the adjoining floodplain where these refuges and rearing habitats formerly existed.

Riprapping affects the stability of IWM along the river channel margin. Stable wood retention is important for creating and maintaining good fish habitat (Bisson *et al.* 1987). Whole trees and their root balls are more important for long term stability than smaller fragments, as they tend to stay in place for long periods of time. These large pieces of wood may remain in place for decades and in the process trap additional IWM, thus adding to the structure. The longevity of large woody debris however may mask changes in the input of woody materials to the river. Since these large pieces of wood would normally be slow to decay, a decline in the woody material input may be masked. Riprapping of the upper river and Delta waterway banks prevents the normal input of upstream woody materials through erosion. The smooth hydraulic roughness along the riprapped banks prevents pieces of woody materials from becoming anchored and remaining in place. The woody materials are transported downstream, but the riprapping of the lower river and Delta waterway banks further limit these pieces from becoming lodged on the banks and the woody material is lost to the system. There is a continuing reduction of IWM input from upstream and local waterways, so that the presence of large pieces of IWM in the Delta is becoming exceedingly rare. Existing pieces that are removed or break apart from decay are not being replenished from upstream.

Like the studies upriver in the mainstem Sacramento River, salmonids in the Delta are associated with natural banks and IWM cover where there is sandy or muddy substrates and shallow water shorelines (McLain and Castillo 2009). Areas with riprap and a lack of cover tended to be dominated by non-native predators and these riprapped shorelines had lower densities of salmonids present. Other studies have shown this trend for non-natives, in particular piscivorous fish that prey on salmonids, (Nobriga *et al.* 2005, Brown and May 2006, Brown and Michniuk 2007, and Grimaldo *et al.* 2012). It is unclear whether the low density of salmonids in riprapped areas is caused by salmon avoiding these areas volitionally or whether they are very vulnerable to predation from non-native predators with a resulting high predation loss (Schmetterling *et al.* 2001, McLain and Castillo 2009).

The continuation of the Corps' ETL policy of no vegetation within 15 feet of the levee toe on both the waterside and landside of the levee greatly exacerbates the negative attributes of the current armored levee habitat in the Delta and Project action area. Removal of the vegetation on the waterside and landside of the levees prevents the input of allocthonous organic materials to adjacent waterways and severely reduces the function of riparian and nearshore habitat along the affected levee reaches. By preventing the input of organic materials that serves as a source of energy and organic carbon, aquatic and terrestrial food webs are negatively impacted. Furthermore, compliance with the ETL policies prevents the establishment of riparian vegetation communities. The ETL policy does not allow woody vegetation to become established that could eventually be recruited into the adjacent aquatic habitat through erosion or death of the woody plants. Allowance of only grasses, sedges, and small bushes to grow on the waterside banks of the levees will not create the full functionality of a riparian zone, or create the equivalent complexity of habitat that a full riparian vegetation community would possess. By reducing or eliminating the potential for establishing riparian communities along the Project's levee reaches, the goals of the NMFS Salmonid Recovery Plan (NMFS 2014) are hampered. Recovery goals that have to do with establishing beneficial habitat in the Delta (Del 1.4; Del 1.7, 1.8, 1.27, and 2.15) are impeded by preventing the establishment of appropriate riparian zones beneficial to listed salmonids and other native species.

Furthermore, the ongoing requirement under the ETL to remove vegetation will typically require the application of herbicides to control vegetation on the levee faces. Herbicides and their additives, such as surfactants, can have negative or deleterious effects upon sensitive receptors, such as fish, invertebrates, or plants, in the aquatic environment. Spraying of herbicides on "unwanted" vegetation can create situations where the herbicides drift into adjacent waters and contaminant those water bodies, or is contained in runoff from surface flow during rain events.

The Corps has proposed constructing a setback levee along portions of the Delta Front levee construction area (Fourteenmile Slough). The existing levee would be partially degraded and a new levee constructed landward of the remnant existing levee. The land between the existing levee and new levee would become a mitigation planting area to offset Project environmental impacts. The Corps anticipates that approximately 14 acres will be created between the water's edge and the vegetation free zone of the new levee. The length of the setback levee is anticipated to be approximately 7,000 feet and the width would vary from 60 to 90 feet. The plans for this action are relatively coarse at this time and still in the conceptual stage. More resolution to the plantings and elevations of the setback levee planting will be developed during the PED phase of the Project. The Corps anticipates that the development of Mitigation and Monitoring Plans (MMPs) will occur during the PED phase in coordination with natural resource agencies and the Corps. While this setback levee will provide very valuable habitat to many native species, its benefits to listed salmonids and green sturgeon are uncertain. Its location is separated from any known active migratory corridor for these fish species, and rearing for juveniles of either the listed salmonids or green sturgeon is unlikely to occur in this area under present environmental conditions. The benefits derived from creating a setback levee in this location to listed salmonids and green sturgeon is likely to be negligible.

Given the extensive loss of upstream spawning grounds and the extreme modification of Delta habitats, careful consideration of the impacts of future levee projects is needed. Future projects should focus on channel margin enhancement to protect and restore key migratory and rearing areas. Degradation of channel margins by retaining riprap and removing riparian and nearshore vegetation should be mitigated onsite first, or at least elsewhere on the migratory corridor. Benefits from offsite mitigation should be carefully evaluated as the species impacted from the Project development may not benefit at all from mitigation conducted elsewhere, particularly if the mitigated area is removed from the migratory corridors of the impacted fish populations (*i.e.*, the ESUs and DPSs of listed fish).

The perpetuation of the current levee system will result in the diminished functioning of the aquatic and riparian ecosystems, which reduces the contributions of these habitats to the survival of rearing and migrating listed species, particularly salmonids. The reduction in the quality and quantity of beneficial habitat through previous actions, and the continued maintenance of these poorly functioning habitats through discretionary actions of vegetation management results in the take of listed fish due to diminished habitat value. This take is in the form of "harm" which is defined as including significant habitat modification or degradation that results in death or injury to listed species by significantly impairing behavioral patterns such as breeding, feeding, or sheltering. This would include the permanent disruption of the interlocking food webs associated with shallow water habitats, the riparian zones, and the floodplains adjacent to the river, as well as the detrimental effects of armoring the waterside levee faces with riprap as described above which includes predation and displacement from the nearshore areas. The Corps has stated that there are approximately 24.5 miles of lineal horizontal flood features in the Project, which NMFS considers as negatively affecting the functioning of the adjacent aquatic habitat. Of this, the Corps estimated that approximately 5 miles (~25,000 feet) of impacted SRA vegetation are located on migratory corridors or waters otherwise considered to be routinely accessible to listed salmonids or sDPS green sturgeon. Of this amount, approximately 20,000 feet will be lost due to Project actions. Since it is impossible with the currently available monitoring data to determine how many individual fish will be taken through the loss or modification of the habitat, NMFS will use the values for lineal feet of SRA impacted and lost on waters bearing NMFS' listed species as ecological surrogates for the detrimental effects upon listed fish.

2.4.1.4 Effects to Critical Habitat

CCV Steelhead Designated Critical Habitat

The effects to designated critical habitat for CCV steelhead related to the direct effects of construction actions will be short lived during each construction season, but will impact critical habitat each year, for 10 years; from 2018 until 2028. Within the action area of the Project, the PBFs for designated critical habitat for CCV steelhead are freshwater rearing habitat, freshwater migration corridors, and estuarine areas. As described earlier in this document, the construction actions are anticipated to create elevated levels of noise due to construction equipment moving on the levees and the actual construction activities themselves, and is particularly relevant to those portions of the action area along the Calaveras River and the portions of the mainstem San Joaquin River adjacent to the mouth of the Calaveras River. These sections are active migratory corridors for CCV steelhead originating in the Calaveras River watershed. The period of active migration for emigrating CCV steelhead smolts in the Calaveras River during spring overlaps with the proposed work window of mid-April through October 31 on the Calaveras River. Noise related to construction equipment and vehicles and the proposed construction activities on the levees will degrade the functioning of the freshwater rearing PBFs during the emigration period. NMFS expects that fish will be startled by the construction activity and temporarily leave the nearshore area while the construction is taking place. NMFS assumes that fish will move to an area of the river that is quieter and resume feeding and holding during their rearing phases. Migration may also be affected by this construction noise. Migration during the daytime may be depressed by the construction activities along the levees, and fish will hold until evening and night before moving through the active construction areas when construction activities cease for the night. Although there is some potential to affect adult upstream migrations in the fall, this would only occur if there was hydraulic connectivity between the upper portions of the Calaveras River watershed and the Delta. Typically this does not happen until after October 31, and the onset of the winter rainy season. Overall, the impacts to critical habitat related to construction equipment traffic and construction activities are expected to be temporary and result in no permanent damage to the PBFs of the designated critical habitat. When construction in a given reach of the levee is completed, the noise from the construction actions ends and no further construction related noise will enter the aquatic system.

Construction of the flood control gates is scheduled to take 2 years, thus the impacts to the freshwater rearing and freshwater migratory corridor PBFs from pile driving will be temporary and will not create any permanent damage to the designated critical habitat in the area. In contrast to the short term immediate effects of construction, the long term effects of building and operating the flood control gates and maintaining the levee slopes will impact freshwater rearing and migratory corridor PBFs for the foreseeable future. As described previously, the flood gate structures have the potential to entrap migrating adult, smolt, and juvenile CCV steelhead during their migratory movements. Fish that are present on the upstream side of the gates when they are closed will experience a delay in their migration (a migratory obstruction) and exposure to potential water quality degradation while the gates are closed. Furthermore, while entrapped or in proximity to the gates when open, smolts and juveniles may experience greater risks from predation, which reduces the quality of the habitat for rearing, as well as for migration.

As previously described in this document, the perpetuation of the levees, their armored riprapped waterside faces, and the removal of vegetation under the ETL for the Project, will diminish the functioning of the action area's waterways for rearing and migration of CCV steelhead. Levees simplify riverine and estuary habitat complexity and reduce the integrity of the riparian and wetland corridors associated with stream borders and sloughs. Levees also isolate the floodplains from the river, destroying the valuable interface between the riparian and the adjacent aquatic communities that depend on an exchange of inorganic and organic materials to fully function. Riprapping the waterside faces of the levees to provide protection against erosion reduces the ability of riparian vegetation to establish itself, changes the hydrodynamics of the river adjacent to the bank in an ecologically unfavorable manner, and reduces and prevents the establishment of IWM along the river's edge. The continued use of the "no vegetation" policy of the ETL as a standard practice of levee maintenance ensures that riparian vegetation will not become established along the levee's waterside face and the area within 15 feet of the toe of the levee. Taken together, the armored levees and the long term implementation of the ETL "no vegetation policy" prevent the designated critical habitat in the action area from reaching its full conservation value.

sDPS of North American Green Sturgeon Designated Critical Habitat

The potential impacts to sDPS green sturgeon critical habitat are similar to that just described for the CCV steelhead critical habitat. In freshwater riverine and estuarine systems, NMFS expects that the PBFs affected by the Project will include food resources, water quality, water depth, and migratory corridors. The construction actions will create temporary noise impacts on the waterways of the action area as described for the CCV steelhead above. Presence of juvenile sDPS sturgeon however are likely to overlap with all of the construction work windows since juveniles are expected to be present year round in the action area, but particularly in the Stockton DWSC and the mainstem San Joaquin River. Adults are most likely to be present in the winter and spring, but may also be present year round in low numbers. Potential effects range from delay of migration through the affected reaches due to behavioral avoidance of the construction sounds to injury or death from the intense levels of sound generated by the impact hammers used to drive the sheet piles for the flood control walls and gates (potentially a complete blockage of migration through the affected area). As described for the CCV steelhead, construction follows a work window that spans 4 to 7 months each year (depending on location) but will continue for 10 years (2018 to 2028) over the course of the Project. Thus, exposure to construction noise will continue intermittently for the next 10 years depending on the work window and the construction locations. There will be no permanent impacts to designated critical habitat due to the construction generated noises, and no noise related effects when construction is not occurring or when construction has been completed in 2028.

The long term effects of the Project on designated critical habitat for sDPS green sturgeon include the potential degradation of water quality in the areas behind the flood control gates. Poor water quality and elevated contaminant concentrations due to low water exchange rates can impact sDPS green sturgeon, particularly juveniles that rear in these waters year round and consume prey exposed to the contaminants. The prey base (green sturgeon food resources) are likely to bioaccumulate some of the contaminants listed in the 303d list for impaired waters that are present in the Smith Canal. Alternatively, prey populations may be diminished due to mortality related to the contaminants present or perhaps a combination of diminished prey populations with the remaining prey populations bearing contaminant loads that are then transferred to the green sturgeon that consume them. Green sturgeon that consume contaminated prey may incur sublethal or lethal effects depending on the load and type of contaminates consumed.

The long term presence of the levees, armored levee faces with riprap, and the "no vegetation" policy of the Corps ETL will impair the functioning of the riparian and aquatic habitats as already discussed in this Opinion. NMFS expects that food resources will be negatively affected due to a lack of riparian and shallow water habitat that would benefit food webs in the action area. Likewise the benefit of diverse channel morphology and variable flows and water depths that a naturally meandering river channel would provide are prohibited from occurring due to the levee construction and armoring. This affects the quality of the migratory corridor, food resources, and variable water depths identified as PBFs for freshwater riverine systems and estuarine habitats.

2.5 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

2.5.1 Water Diversions and Agricultural Practices

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found along the riverine and Delta sloughs within the action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren and Kawasaki 2001). Many of these intakes are minimally regulated by either State or Federal agencies, having been in place for decades.

Agricultural practices in the action area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the action area. Numerous dairy operations occur to the north of Stockton, with sloughs and irrigation canals running through these facilities to the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003).

2.5.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habits that have already been permanently lost as a result of dam construction. The loss of this available habitat results in dramatic reductions in natural population abundance which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations. The high level of hatchery production in the CV can result in high harvest- to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources between hatchery and wild fish, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production. Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.5.3 Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. There are multiple boating facilities (private and public docks and marinas) within the immediate vicinity of the action area that would draw boaters to the area. In addition, the DWSC is a main access point for boaters traveling between the Stockton area and the western Delta and is heavily utilized by recreational boaters. Any increase in recreational boating due to population growth would likely result in increased boat traffic in the action area. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially resuspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation in the Delta is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the water bodies of the Delta. Furthermore, increased recreational boating, particularly those that can be trailered from one water body to another, greatly increases the risk of spreading non-native invasive species into the Delta.

Increased commercial activity in the Port of Stockton has the potential to increase commercial shipping in the Port of Stockton. Increased commercial shipping increases the potential for spills of petroleum products and other lubricants into the DWSC from the large vessels, as well as the introduction of non-native invasive species into the area waterways through the discharge of ballast waters. Ship movements increase the resuspension of sediments from the channel bottom which may introduce contaminants into the water column and increase turbidity in the DWSC. Finally, increased shipping traffic may increase the risks of propeller entrainment and propeller strikes to listed fish in the DWSC. Propeller strikes are particularly dangerous to adult sturgeon (Brown and Murphy 2010, Balazik *et al.* 2012).

2.5.4 Global Climate Change

The world is about 1.3°F warmer today than a century ago and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (Intergovernmental Panel on Climate Change [IPCC] 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data, Huang and Liu (2000) estimated a warming of about 0.9 °F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting salmonid PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to outcompete native fish species and impact predator-prey relationships (Peterson and Kitchell 2001, Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the Central Valley has been modeled to have an increase of between 2°C and 7°C by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, Van Rheenen *et al.* 2004, Dettinger 2005), with a drier hydrology predominated by precipitation rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the Central Valley from a spring/summer snowmelt dominated system to a winter rain dominated system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff. This should truncate the period of time that suitable cold-water conditions exist below existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures below reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.*, Sacramento River winter-run Chinook salmon and California Central Valley steelhead) that must hold below the dam over the summer and fall periods.

2.5.5 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions as well as illegal placement of riprap occur within the watersheds of the Sacramento, Calaveras, and San Joaquin rivers, as well as the waterways of the

Delta. For example, most of the levees have roads on top of the levees which are either maintained by the county, reclamation district, land owner, or by the state. Landowners may utilize roads at the top of the levees to access parts of their agricultural lands and repair the levees to protect property with unauthorized materials (*i.e.*, concrete rubble, asphalt, etc.). The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with the Project.

2.6 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, NMFS add the effects of the action (section 2.4) to the environmental baseline (section 2.3) and the cumulative effects (section 2.5), taking into account the status of the species and critical habitat (section 2.2), to formulate the agency's Opinion as to whether the proposed action is likely to: (1) reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) reduce the value of designated or proposed critical habitat for the conservation of the species (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. NMFS described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, NMFS also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action and cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.
The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, NMFS also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of

extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this Opinion. NMFS then consider how the status of populations in the action area, as described in the *Environmental Baseline*, is affected by the proposed action. Effects to individuals are summarized, and the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the physical and biological features (essential features) within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to: (1) space for individual and population growth, and for normal behavior; (2) food, water, air, light, minerals, or other nutritional or physiological requirements; (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring; and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species [see 50 CFR § 424.12(b)]. In addition to these factors, NMFS also focuses on the principal physical and biological features within the defined area that are essential to the conservation of the species. Physical or biological features may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation.

The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.6.1 Summary of the Status of the CV Spring-Run Chinook Salmon ESU

The CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2011 status review (NMFS 2011a). This review found that the biological status of the ESU has worsened since the last status review. In the 2011 status review, the ESU as a whole could not be considered viable because there were no extant viable populations in the three other diversity groups outside of the northern Sierra diversity group. In addition, Mill, Deer, and Butte creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), NMFS cannot say based on the trend over the past four years that the risk of extinction for the ESU has improved. In light of this, NMFS is attempting to re-establish CV spring-run back into the San Joaquin River basin where it historically occurred, creating an additional "diversity group" in formally occupied habitat. It is the members of this experimental population and their progeny that will be present in the Project's action area.

2.6.2 Summary of the Status of the CCV Steelhead DPS

All indications are that natural CCV steelhead have continued to decrease in the abundance and in the proportion of natural fish to hatchery origin fish over the past 25 years (Good et al. 2005; NMFS 2011b); the long-term natural population trend remains negative. Hatchery production and returns are dominant over natural fish, and one of the four hatcheries is dominated by Eel/Mad River origin steelhead stock. There is a continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts, indicating that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent stream habitat restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin River basin continue to show an overall very low abundance, and fluctuating return rates. This particular diversity group (southern Sierra Nevada) is at a high risk of extirpation due to its low numbers and the precarious conditions of its spawning and rearing habitats below the rim dams in the basin's tributaries. The southern Sierra Nevada diversity group is the population of CCV steelhead most likely to be present in the action area. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that the available data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, where ladder counts are made at the hatchery. These wild populations are likely to be at a high risk of extinction due to the extensive spawning of hatchery-origin fish in the natural areas occupied by the wild populations.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, most wild CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011b). The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish populations. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

The CCV steelhead DPS is at high risk of extinction (NMFS 2011b), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011b). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions.

2.6.3 Summary of the Status of the sDPS of North American Green Sturgeon

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010a, 2015).

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists that spawns in the Sacramento River basin, but that some sporadic spawning may occur in tributaries to the mainstem when conditions permit (Seesholtz *et al.* 2015). Lindley et al. (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010a, 2015).

Adult green sturgeon potentially migrate through the action area to reach upstream riverine habitat based on catches of green sturgeon in the San Joaquin River mainstem, upstream of the Delta (CDFW sturgeon report card data). Juvenile green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (Allen and Cech 2007). Juvenile and subadult green sturgeon may rear in freshwater and brackish water for up to three years in the Delta, including the Project's action area. During laboratory experiments, juvenile green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile green sturgeon were captured during the summer in shallow shoals (1-3 m deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats in other Delta region waterways.

There is a strong need for additional information regarding sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.6.4 Summary of the Status of the Environmental Baseline and Cumulative Effects in the Action Area

The action area is used by the southern Sierra Nevada Diversity Group of CCV steelhead, the San Joaquin River basin experimental population of CV spring-run Chinook salmon, and the sDPS of green sturgeon and are the groups of listed fish that are the subject of this Opinion. Salmon, steelhead and green sturgeon use the action area as an upstream and downstream migration corridor and for rearing.

Within the action area, the essential features of freshwater rearing and migration habitats for salmon, steelhead and green sturgeon have been transformed from meandering riverine waterways and sloughs lined with a dense riparian vegetation and emergent marshes, to a highly leveed system under varying degrees of constraint, prohibiting natural riverine erosional processes and seasonal flooding of adjacent riparian benches and floodplains. Levees have been constructed near the edges of the San Joaquin and Calaveras rivers and regional Delta sloughs. These levees completely separate and isolate most floodplains from these waterways (USFWS 2000, Schmetterling *et al.* 2001)). Severe long-term riparian vegetation losses have occurred in the Delta, including those parts of the lower San Joaquin River and the eastern Delta and tributaries in the action area, and there are large barren reaches without the presence of these essential riparian features due to the high amount of armoring riprap present (USFWS 2000). The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, and the removal of riparian vegetation and IWM have likely negatively affected the functional ecological processes that are essential for growth and survival of salmon, steelhead and green sturgeon in the action area.

The *Cumulative Effects* section of this Opinion describe how continuing or future effects such as non- Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that reduce the carrying capacity of the rearing and migratory corridors.

2.6.5 Summary of Project Effects on CV spring-run Chinook salmon, CCV steelhead, and sDPS Green Sturgeon Individuals

1) Direct Short-term Construction Related Effects

a) CV Spring-run Chinook salmon

NMFS considers the predominant origin of CV spring-run Chinook salmon in the Project's action area to be derived from the experimental populations released into the San Joaquin River as part of the SJRRP effort. Individuals from these releases and any future progeny are afforded threatened status under the ESA once they leave the area of introduction. NMFS expects that the experimental population (and their naturally spawned progeny) will exhibit life history traits similar to their stocks of origin, particularly regarding run timing of adults and emigration timing of smolts. NMFS expects that adults returning in late winter and continuing through June will not be exposed to any construction actions in the mainstem of the San Joaquin River due to the proposed work window of mid-July through October 31. Likewise, young of year juveniles and smolts should not overlap with the construction work window during their outmigration in the San Joaquin River.

Construction work windows in the Calaveras River and the action area sloughs are from mid-April through October 31, thus there is the potential for several months of overlap for adults and young of the year juveniles and smolts from mid-April through June. Water temperatures in the mainstem San Joaquin River and ambient flows after June would typically be marginal for the survival of emigrating juveniles or for attracting adults upriver. The likelihood that fish would be present in any of the sloughs other than French Camp Slough is low. The other sloughs in the action area are isolated from the main migratory corridors for the CV spring-run population of interest by miles of channels and the presence of either adults or juveniles is considered unlikely. Fish presence in the tidal reaches of the Calaveras River or in French Camp Slough in close proximity to the San Joaquin River is more likely. These fish have the possibility of being exposed to both construction related noise due to levee rehabilitation and turbidity directly related to the construction actions, but not pile driving actions associated with the construction of the flood control gates and sheet pile walls. This later action will take place during the summer work period when CV spring-run Chinook salmon are not expected to be present in the action area waterways. None of the exposures are considered to be life threatening and will likely only amount to harassment or behavioral modification of their migration (and any rearing behavior that may occur for juveniles). NMFS expects that fish may be startled by construction noise and activities on the upland portions of the levees and flee the area. Turbidities are unlikely to increase to a level where any long lasting physical damage occurs, rather only behavioral changes are anticipated (*i.e.*, reduced foraging success, leaving the area of the turbidity plume). The impact to individual fish is considered to be of low intensity and no injury or mortality is expected to occur, thus the impacts to the population in the San Joaquin River basin and to the CV spring-run Chinook salmon ESU are considered to be minimal for the direct construction effects.

b) CCV Steelhead

NMFS considers the predominate origin of CCV steelhead in the action area to be either from the San Joaquin River basin tributaries or from the Calaveras River basin and thus are members of the Southern Sierra Nevada Diversity Group. A portion of the steelhead present in the San Joaquin River basin are hatchery strays from other river basins, since adult adipose fin clipped fish are identified each year in tributary monitoring (*i.e.*, fish weirs), but no steelhead hatcheries are present in the San Joaquin River basin. Adult steelhead typically enter the basins waterways starting in early fall (September and October) but do not peak until early winter (November through January) and may continue through early spring. Smolts typically enter the Delta from March through June, with peaks in April and May and continuing into June, dependent on ambient water temperatures and flows in the basin.

Construction activities in the mainstem of the San Joaquin River from mid-July through October 31 may expose the early portion of adult returns in September and October. It is unlikely that emigrating steelhead smolts will encounter construction activities since the construction window ends (October 31) before steelhead smolt emigration starts in the basin and doesn't start back up (mid-July) until the smolts are done emigrating.

Construction work windows in the Calaveras River and the action area sloughs are from mid-April through October 31, thus there is the potential for several months of overlap for adult steelhead and smolts from mid-April through June with construction activities. Adults entering the Calaveras River must wait until the upper watershed below New Hogan Dam connects hydraulically with the tidal reaches of the lower Calaveras River in the action area before migrating upriver. This usually doesn't occur until after winter rains create higher flows in the upper river. Adult steelhead may be holding in the tidal reaches of the Calaveras River as early as September and October waiting for the flows to increase and create the connection. These fish may be exposed to the end of the work window while holding. Steelhead smolts trying to emigrate downstream to the Delta may be present at the mid-April start of the construction season in the lower Calaveras River and therefore be exposed to construction actions. This earlier start date also applies to the other sloughs in the action area. The likelihood that fish would be present in any of the sloughs other than French Camp Slough is low. The other sloughs in the action area are isolated from the main migratory corridors for the CCV steelhead population of interest by miles of channels and therefore the presence of either adults or juveniles is considered unlikely.

Those fish present in the action area when construction activities are taking place on the levees have the possibility of being exposed to both construction related noise due to levee rehabilitation and turbidity directly related to the construction actions. Those adult steelhead present in September and October also have the possibility of exposure to pile driving actions associated with the construction of the flood control gates and sheet pile walls, which will be addressed separately below. Exposure to construction related noise from levee rehabilitation and construction equipment traffic is not likely to reach levels where injury or mortality will occur. The more likely result of this exposure is harassment or behavioral avoidance of the noise. This will result in a minor impact to rearing and migratory behaviors as it is expected that fish will leave the area where the construction activities are taking place and return once the noise has abated. Furthermore, since the expected noise levels are of low intensity and only occur during the day when construction activities are happening, fish can move at night or move through the construction area without injury even if noise is occurring. There is also the potential for exposure to turbidity plumes from the exposed soil levee surfaces during construction, particularly during spring precipitation events. Rain in the September and October time frame is less likely to occur. The Corps has indicated in their BA that they will implement conservation measures to prevent erosion and turbidity from occurring by using construction BMPs to minimize or avoid erosion and sediment transport in the work zones. Implementation of these BMPs will reduce the impact of turbidity on exposed fish to negligible levels.

The impacts of the pile driving actions associated with the installation of the flood control gates and sheet pile walls are more severe than the levee rehabilitation construction activities. NMFS expects that the main exposure to the pile driving actions will occur at the Smith Canal gate location due to its close proximity to the DWSC and the Calaveras River confluence. Pile driving actions associated with the Fourteenmile Slough location are not expected to affect CCV steelhead since this site is isolated by miles of delta waterways that separate it from the main channel of the San Joaquin River. The main channel of the San Joaquin River acts as the prime migratory corridor for CCV steelhead in the watersheds of the San Joaquin and Calaveras rivers. NMFS anticipates that pile driving exposure will occur if the construction window for the flood control gates slips from mid-July through mid-September to a later date in the work window that occupies more of the September through October time frame. The Corps' BA states that pile driving actions will occur over a 2 month period each work season for the two years that it is anticipated to take to construct the gates and sheet pile walls. If the pile driving occurs during the anticipated summer work window, then the exposure of CCV steelhead to the pile driving is limited to early arriving adults in the DWSC adjacent to the Smith Canal location in early September.

The radius of adverse effects resulting from the use of impact hammers to drive the approximately 435 sheet piles each year will cover the entire channel width from the location of the Smith Canal flood control gates to the opposite shoreline of the DWSC on Rough and Ready Island. Injury or death from single strike noise levels exceeding a peak of 206 dB will extend 9 meters from the sheet pile being driven by the impact hammer. Injury or death from exposure to the 187 dB $SEL_{accumulated}$ over the course of a day will extend out to 710 meters (~ 2,300 feet). The channel width is only 500 to 800 feet wide at the Smith Canal construction location, therefore all fish passing through this reach will be exposed to sound levels that will likely result in injury or death during this phase of the flood gate installation.

For installation of the 24-inch diameter concrete pilings with an impact pile driving hammer, the range of injury or death for a single strike peak noise level of 206 dB is less than 1 meter. The range to the 187 dB $SEL_{accumulated}$ threshold for injury or death is approximately 46 meters (~150 feet) and encompasses approximately 20 to 30 percent of the channel width. Levels of noise that would elicit behavioral response (> 150 dB) would span the entire channel width.

For installation of the sheet piles with a vibratory hammer, the range at which the received sound levels will exceed the level of risk for an adult steelhead for auditory or non-auditory tissue damage (234 dB) is at the point source (zero distance). Thus, there is no risk to adult salmonids when using the vibratory hammer, based on the criteria from Hastings (2010) for tissue damage. The distance at which behavioral effects (>150 dB) occur is 74 meters (250 feet), which covers approximately 30 to 50 percent of the DWSC width at the Smith Canal location.

NMFS anticipates that the Corps will conduct most of its pile driving actions during the summer, and only the last two to three weeks of the gate installation will occur in September and thus overlap with a small fraction of the adult steelhead migration. It is also expected that pile driving will only take place during the daylight hours, therefore allowing free passage of fish during the nocturnal periods when pile driving is not occurring and no adverse sound effects related to the construction activities are present. After 2019, no more pile driving will occur at the Smith Canal location.

NMFS anticipates that only a small number of adult steelhead from the Southern Sierra Nevada Diversity Group will be present during the pile driving actions and therefore be exposed to the adverse effects of the action. Individual fish that are present during the pile driving actions, particularly when the impact hammer is used to drive the sheet pile sections to their final tip depth, may suffer injury or death from their exposure. Since the majority of adult steelhead migrants are not expected to be present until several weeks later in November and December, when the construction window has closed for the season, NMFS believes that most of the population will be unaffected by the pile driving actions. Therefore, the impacts to the Southern Sierra Nevada Diversity Group of CCV steelhead will be minimal in regards to the pile driving actions. This will translate to a low effect to the overall CCV steelhead DPS in relationship to the pile driving actions, as the majority of the DPS exists outside of the action area and will not be exposed, and since the Southern Sierra Nevada Diversity Group will be minimally impacted, thus preserving the spatial diversity necessary for the DPS viability according to Lindley *et al.* (2007), the overall status of the CCV steelhead DPS will not be changed.

c.) sDPS of North American Green Sturgeon

NMFS considers that all green sturgeon that are found within the action area are from the sDPS of green sturgeon. It is highly unlikely that any individuals from the nDPS will be found this far upstream into the Delta. Juvenile sDPS green sturgeon are assumed to be present in the action area year round, as the juveniles may spend 1 to 3 years in the Delta rearing before emigrating to the marine environment as sub-adults. Adult sDPS green sturgeon typically enter the estuary from the ocean starting in January and February and move upstream towards their spawning grounds in the Sacramento River basin through the spring. Some adults may return downstream in late spring or early summer either as successful or unsuccessful spawners. Other adults may hold upriver and move downstream starting at the end of summer and continuing into the fall and early winter. Therefore, adult green sturgeon may be found year round in the Delta, as indicated by the sturgeon fishing report cards collected by the CDFW, with the fewest typically present in the summer. In addition, the annual sturgeon report cards indicate, that at least on occasion, individual green sturgeons are caught in the San Joaquin River upstream of Stockton, implying that they have the potential to move through the action area via the DWSC and the San Joaquin River. NMFS also believes that both adult and juvenile green sturgeon will utilize deeper channels and holes to hold and move, at least during the day, and then make forays into shallower water to forage. NMFS does not believe that green sturgeon will utilize the waterways and sloughs in the north Delta portion of the action area, including Fourteenmile Slough, Fivemile Slough, Mosher Slough, and Ten Mile Slough to the same extent as the DWSC and the mainstem San Joaquin River. As indicated for spring-run Chinook and CCV steelhead, these waters are isolated from the main channels of the San Joaquin River and are relatively shallow with little inflow. Green sturgeon may utilize the tidal portion of the Calaveras River as it is in close proximity to the San Joaquin River and has both tidal and riverine flows associated with it. In a similar fashion, green sturgeon are likely to be found at the junction of French Camp Slough and the San Joaquin River since it is in close proximity to a migratory corridor for sturgeon.

Green sturgeon will be exposed to construction activities and construction vehicle noise throughout the work windows from mid-April through October 31 in the Calaveras River and action area sloughs, and from mid-July through October 31 in the mainstem San Joaquin River. The Project will have 3 years of construction activities in the Central Stockton area from 2018 to 2020, and 8 years of construction activity in the North Stockton portion of the action area from 2021 to 2028.

Those fish present in the action area when construction activities are taking place on the levees have the possibility of being exposed to both construction related noise due to levee rehabilitation, and to turbidity directly related to the construction actions. Exposure to construction related noise from levee rehabilitation and construction equipment traffic is not likely to reach levels where injury or mortality will occur. The more likely result of this exposure is harassment or behavioral avoidance of the noise. This will result in a minor impact to rearing behavior in juveniles and migratory behaviors in adults as it is expected that fish will leave the area where the construction activities are taking place and return once the noise has abated. Furthermore, since the expected noise levels are of low intensity and only occur during the day when construction activities are happening, fish can move at night or move through the construction area without injury even if noise is occurring. The nocturnal behavior of juvenile sturgeon may further reduce exposure as fish may not utilize the shallow areas near the levees until night time, and thus reduce their proximity and exposure to the noise generated during the day. There is also the potential for exposure to turbidity plumes from the exposed soil levee surfaces during construction, particularly during spring precipitation events. Rain in the September and October time frame is less likely to occur. The Corps has indicated in their BA that they will implement conservation measures to prevent erosion and turbidity from occurring by using construction BMPs to minimize or avoid erosion and sediment transport in the work zones. Implementation of these BMP will reduce the impact of turbidity on exposed fish. Moreover, sturgeon routinely occupy turbid waters so that elevations of turbidity along the shorelines from runoff may not have any noticeable effects upon exposed sturgeon.

The impacts of the pile driving actions associated with the installation of the flood control gates and sheet pile walls are more severe than the levee rehabilitation construction activities. NMFS expects that the main exposure to the pile driving actions will occur at the Smith Canal gate location due to its close proximity to the DWSC. Pile driving actions associated with the Fourteenmile Slough location are not expected to affect sDPS green sturgeon since this site is isolated from the main channel of the San Joaquin River. The main channel of the San Joaquin River acts as the prime rearing and migratory corridor for sDPS green sturgeon in this portion of the Delta.

Pile driving activities will last approximately 2 months each year for the two years that are projected for the completion of the Smith Canal flood control gate. Exposure is expected to occur over the summer from mid-July to mid-September. Based on this timing, NMFS believes that mainly juvenile green sturgeon will be exposed to the pile driving activities. Adult green sturgeon are least likely to be present during the summer. The data found in the CDFW sturgeon report cards imply that summer is the least likely time to catch green sturgeon in the San Joaquin River and Delta, as compared to the fall, winter, and spring periods.

The exposure risks of the pile driving upon green sturgeon will have the same distances and thresholds to injury as previously described for the CCV steelhead above. The only potential difference to exposure risk is the bathymetry of the DWSC in relation to the location of the Smith Canal gate structure. The gate structure is on a shallow bench that drops off sharply into the DWSC dredged channel. Fish located on the bottom of the channel may have some protection from the noise generated by the pile driving actions. Sound waves traveling away from the gate structure location will have to "bend" or spread to ensonify the channel bottom of the DWSC. This spreading will diminish the strength of the sound wave as it travels. However, sturgeon laying on the bottom may also receive sound waves traveling through the substrate, although these will be of a lower intensity than those in the water column above it. Any sturgeon located on the shallow bench, as well as up high in the water column, will receive the full intensity of the generated sound waves emanating from the sheet pile being driven into the substrate.

NMFS anticipates that only a very small number of adult green sturgeon will be present during the pile driving actions and therefore be exposed to the adverse effects of the action. Most individuals that will be exposed to the pile driving actions are expected to be juveniles rearing in the DWSC in the vicinity of the Smith Canal gate structure. Individual fish that are present during the pile driving actions, particularly when the impact hammer is used to drive the sheet pile sections to their final tip depth, may suffer injury or death from their exposure.

Since the majority of adult green sturgeon are not expected to be present until later in the fall and winter when the construction window has closed for the season, NMFS believes that most of the adult population utilizing the San Joaquin River and DWSC will be unaffected by the pile driving actions. Furthermore, the majority of adult green sturgeon, as represented by catch numbers in the report cards, are located in the Sacramento River waterways and western Delta and not in the San Joaquin River. The avoidance of the adult population to the effects of the pile driving actions protects the future spawning potential of those adults. The loss of juveniles is likely to occur as a result of the pile driving. The relative number of juveniles that are anticipated to be present in the DWSC adjacent to the Smith Canal location is small compared to the number of juveniles present in the Delta as a whole, based on the relative area of habitat available to juveniles throughout the Delta. Therefore, the impacts to the adult and juvenile sDPS green sturgeon population will be minimal in regards to the pile driving actions, as the majority of the DPS exists outside of the action area and will not be exposed.

2) Direct Long-term Construction Related Effects

a) Smith Canal Gate Structure

All species considered in this Opinion have the potential to encounter the Smith Canal gate structure during their normal migratory movement and rearing behaviors in the San Joaquin River. All species will be present at some point in time when the Corps anticipates the gate will be operated to protect against high water elevations (November 1 through April 30). This period overlaps with both adult and juvenile migrations of CCV steelhead and the re-introduced population of CV spring-run Chinook in the San Joaquin River basin. Juvenile green sturgeon are assumed to be present year round in the DWSC location adjacent to the Smith Canal location. Adult green sturgeon are assumed to be present primarily from fall through spring in the DWSC based on the sturgeon report card data.

All species will be affected by the poor water quality behind the flood control gates in Smith Canal if entrapped by the operations of the gate for flood protection. NMFS expects that water quality will degrade in the future due to a decrease in tidal flushing of the Smith Canal waterway and an increase in the residence time of water behind the sheet pile walls due to the obstruction of the channel. Salmonids and sturgeon tend to be sensitive fish species to reduced water quality compared to other fish species, particularly non-native species such as centrarchids, ictalurids, and cyprinids that now are common in the Delta.

As mentioned earlier in the effects analysis, it is uncertain what fraction of the listed fish populations will be present when the gates are operated, and of that fraction present, how many will be entrapped behind the gates. It is certain that those fish trapped behind the gates will be exposed to more highly degraded water quality conditions than those fish remaining outside the gates, and will likely have a higher risk of predation while remaining behind the gates. NMFS assumes that fish trapped behind the gates are likely to be lost to the system. However, when the gates are closed, no additional listed fish are exposed to the degraded water quality or to any additional predator risk behind the gates for the duration of the closure. In contrast, when the gates are operated frequently, as for the high tide events, more fish are potentially exposed to entrapment behind the gates, but for shorter periods of time. Without site specific information, it is impossible to say whether more fish are lost when the gates are closed for a longer duration with less frequency of operation, or if more fish are lost due to shorter closures with a higher frequency of operations.

An additional threat to listed fish, but in particular CCV steelhead smolts and juvenile CV spring-run Chinook salmon, is the high velocity flow of water through the open gate of the structure during the tidal cycle each day. As explained in the effects analysis, the differences in water elevation between each side of the flood control structure during tidal changes will create head differentials that induce high velocity flows of water through the relatively narrow 50 foot gate structure. Such high flows create velocity shears with resulting eddies and turbulence in the narrow channel, which predatory fish use to their advantage to prey on smaller fish such as steelhead smolts and Chinook salmon juveniles. By creating this hydrodynamic condition in association with vertical structure in an open water environment to which predators will congregate, the level of predation risk is increased beyond what was originally present in this location. It is unknown whether juvenile green sturgeon will be as vulnerable to predation as salmonids, but it is likely that some predation will occur.

It is also unknown how adult salmonids will react to this hydrodynamic feature of the gate structure. Adult fish may be attracted to the outflow of water from the gate structure on the falling tide and congregate in the area of the gate. This may increase their vulnerability to predation by sea lions that are observed in the DWSC on occasion. Sea lions may become habituated to the presence of adult fish in proximity to the gate structure and increase their predation rates on these congregating adult fish.

The risk presented to the populations of listed CCV steelhead, CV spring-run Chinook salmon and sDPS green sturgeon by the long term operations and presence of the Smith Canal flood control structure is uncertain. The proportion of the populations that will come in contact with the gate structure as fish migrate through the DWSC is unknown, since neither the spatial distribution of fish across the channel nor the use of the shallow bench along the northern river bank by the different fish species and life stages is known. However, it is certain that the gate structure enhances the risk to passing salmonids and green sturgeon above the current conditions and therefore should be considered as adversely affecting the populations of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon in the action area. The presence of the gate structure will continue into the foreseeable future, thus creating a perpetual source of poor water quality and predation impacts to the action area, and a permanent adverse effect to the listed species. The frequency of closure for short term operations (tidal) is estimated to occur approximately 10 times a month during January and February, but gate closures should last no more than 6 to 12 hours. Taking the maximum closure time of 12 hours and a closure frequency of 10 times per month in January and February, the gates will be closed approximately 17 percent of the time during these two months. For flood events, the Corps has estimated that the gates will be closed on average three times a year from a few days to a few weeks based on the past 20 years of hydrology records. If the gates are closed for 3 weeks every year for high water elevations due to tides and inflow, then the gates are closed approximately 12 percent of the time out of 25 weeks (November through April).

NMFS finds that the frequency of the closures and their duration will not substantially affect the experimental population of CV spring-run Chinook salmon moving past the Smith Canal flood control gates. Gates will be operated for approximately 17 percent of the time in January and February when a few adults may be moving upriver to spawning grounds. The majority of adults are expected to migrate upriver later in the year. Few CV spring-run Chinook salmon juveniles or smolts would be expected to be moving downstream at this time past the Smith Canal flood gate location, thus exposure to the tidal operations are limited. Some individuals may be present and subsequently entrapped by the operations of the gates and lost. NMFS also finds that the numbers of CV spring-run Chinook salmon adults or juveniles from the experimental population that will be entrapped by closures of the gate for "high water inflow events" to the Delta is likely to be small compared to the overall population and thus is not likely to affect the population substantially. The gates may be closed for approximately 12 percent of the operating season (3 weeks out of 25 weeks; November through April) but will only amount to three gate closures per year on average. Thus, there are only three events per year that will trap fish behind the gates. It is unlikely that these three closure events will overlap with a substantial proportion of the population being present at the gate when it is closed. While the gates are closed during high water events, juvenile and adult fish in the DWSC are unaffected by the presence of the gate structure. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CV spring-run Chinook salmon in the ESU. The low impact to the CV spring-run experimental population and its progeny over the foreseeable future will not substantially affect the larger CV spring-run Chinook salmon ESU population and will not negatively affect its viability.

NMFS finds that the operation of the Smith Canal flood gate is unlikely to substantially affect the population of CCV steelhead moving past the Smith Canal flood control gates. Gates will be operated for approximately 17 percent of the time in January and February when adults may be moving upriver to spawning grounds, leaving the gates open for 83 percent of the time. The majority of adults are expected to migrate upriver in December and January with the run tapering off quickly in February and March. The gate operations for tides overlaps with a significant proportion of the adult spawning run, however, there is low probability of steelhead being attracted into Smith Canal due to a lack of any tributary inflow, although some false attraction may be created by the high velocity currents described above as a result of tidal elevation differentials. The duration of any entrapment for adults in response to tidal operations will be typically brief, and exposure to contaminants should not result in mortality. CCV Steelhead smolts are not likely to be emigrating downriver at the time that gates are being operated for the high tides. Therefore, there is a low risk of smolts being entrapped by the gates closing. Gate closures for high water events due to high inflows will result in an average of three closures per year, meaning that there are only that many gate closures to entrap adults or juveniles. While the fish trapped behind the gates for flood closures are likely to be lost to the population, there are no new fish being entrapped by gate operations on additional days while the gates remain closed. As already discussed for CV spring-run Chinook salmon, the number of fish present when the gates are closed, and subsequently trapped behind the closed gate, is unlikely to represent a substantial proportion of the population present in the system, thus impacts to the entire population are minimal. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CCV steelhead in the DPS. The low impact of the Smith Canal gate to the CCV steelhead population in the San Joaquin River basin over the foreseeable future will not substantially affect the larger CCV steelhead population and will not negatively affect it viability.

NMFS finds that the operation of the Smith Canal flood gate is not likely to substantially affect the population of sDPS green sturgeon in the Central Valley. The gates will be operated when both juvenile and adult green sturgeon are present in the vicinity of the gate structure. Individual fish may be present in the DWSC and potentially on the flats in front of the gates and thus may become vulnerable to entrapment behind the gates when they are closed. Some of these individuals may be lost to the population. However, available information indicates that green sturgeon are present in low densities and numbers in this area of the Delta based on the low numbers of fish catches on the CDFW sturgeon report cards, compared to other areas of the Delta. The majority of reported green sturgeon catches in monitoring efforts and sport fishing catches indicate that green sturgeon utilize other areas of the Delta and Sacramento River watershed for their life history needs, rather than the DWSC in the Port of Stockton. Using the same reasoning as given for CV spring-run Chinook salmon and CCV steelhead, there is a low likelihood of trapping green sturgeon behind the gates due to the low frequency of gate closures overall, compared to the time they are open, and the low numbers of fish present. The loss of the few individual fish that are trapped behind the gate when it is closed will not substantially affect the overall population of green sturgeon in the Central Valley and should not impair the viability of the DPS.

b.) Direct Long-term Erosion from Construction Actions

The Project's construction activities will create exposed soil on the levee faces on both the waterside and landside of the levees. The Corps has proposed construction BMPs to reduce and minimize erosion during the construction activities, including hydoseeding the exposed soils with native grasses. The intent is to create a layer of vegetation to prevent rain events from eroding soils on the levee faces that can then be carried by the surface runoff into adjacent waters. The Corps has not described any long term management of these levee surfaces to ensure that the hydroseeded surfaces are actually successful in establishing a grass cover. The Corps has stated in their BA that the responsibility for long term management of the levees belongs to the local sponsors after construction is completed, and not to the Corps. Thus, it appears that the long term management of levee erosion control belongs to the local sponsors, and is not under the authority of the Corps. It normally takes several weeks to months to establish a cover of grass after seeding and typically some form of irrigation is required to promote growth. If no irrigation is provided, the growth of grass is not likely to occur until after the first rains in the fall or winter, at which time the bare levee soils are vulnerable to erosion until the grass attains the necessary coverage and density to prevent erosion from occurring. Bare soils with little or no vegetative cover are likely to have significant erosion. It is during this period that localized turbidity events are likely to occur in the waterways adjacent to the bare soil levee faces. The level of turbidity will depend on the percent coverage of grass on the levee face, the density of the actual grass plants in the vegetated areas, as well as the intensity of the rain event.

NMFS does not expect that the erosion on the levees will reach the levels that adjoining waters are compromised for listed salmonids due to turbidity. Such erosive actions are likely to be prevented from continuing by the local reclamation districts eventually performing maintenance actions in areas showing signs of erosion to protect their levees. Corrective actions such as placement of straw on exposed levee faces or installing straw wattles to check runoff are typically carried out. NMFS believes that the effects of localized turbidity events from post construction erosion will not substantially affect the CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon using the action area waterways. Fish rearing and migration may be temporally disrupted but long term effects should be minimal. Furthermore, turbidity events in the Project's action area related to post construction erosion will not affect populations of listed fish in other areas of the Central Valley and should not affect their viability.

3) Long Term Effects of Levees, Loss of Riparian Habitat, and Vegetation Management under the ETL

The Project, through its maintenance of the levee structures in their current alignment with riprap armoring will perpetuate the miles of engineered shoreline in the action area. As described in the effects analysis, levees replaced the naturally occurring shallow water habitat that existed along the banks of rivers and sloughs in the Delta that provided a spectrum of habitat complexities. Shallow water habitats had a broad range of depths and water velocities due to the presence of shallow water and riparian vegetation, fallen trees and woody materials (*i.e.*, IWM) that existed on their banks, and coupled with the ability of the river to migrate across the floodplain, created additional complexity in the geometry of the river's cross section. Levees isolated the rivers from these floodplains. This has removed the vital role of the seasonally inundated terrestrial floodplains in the Delta ecosystem, which provided valuable nutrients, organic carbon, energy, refugia, and rearing habitat for native fish species including the listed salmonids and green sturgeon that are the subject of this Opinion.

Within the Project area, the levees have existed for over a century due to early reclamation of the Delta for agriculture (The Bay Institute 1998). This isolation from floodplains and the removal of riparian zone vegetation and habitat has become part of the baseline for the action area. The degradation that levees created on the Delta ecosystem was exacerbated by the practice of armoring them with rock riprap to provide erosion protection. The negative aspects of riprap have already been described in section 2.4.1.3 of this Opinion. Riprap impedes the establishment of riparian vegetation, which is already severely constrained by the presence of the levees and their alignment along the area's waterways which isolated the waterways from their adjacent floodplains.

In the current Project proposal, the Corps has estimated that approximately 20,000 lineal feet of a potential 25,000 lineal feet of existing SRA in the Project area will be lost along the lower levee waterside faces. In addition, approximately 9 acres of woody riparian vegetation is expected to be lost along the lower waterside faces of levees in the Project area. Almost all of this loss occurs along the San Joaquin River, Calaveras River and French Camp Slough. These areas are part of the migratory corridors used by the species under consideration in this Opinion. To mitigate for these losses, the Corps has incorporated as part of the Project proposal, a 7,000 foot long setback levee along the Delta Front (Fourteenmile Slough). In addition, the Corps has committed to purchasing credits from the Cosumnes River Floodplain Mitigation Bank (2 credits acres of floodplain mosaic wetland to compensate for one acre of permanent open water impacts and 3 acres of temporary open water impacts) plus shaded riverine credits and floodplain mosaic wetlands for losses of SRA. As previously described, these mitigation measures do not occur along the migratory corridors or within habitat that are used by the CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon affected by the Project. The preferred location for mitigation would be along the migratory corridors used by these fish so that they would derive benefits from them.

The effects of these perpetuated changes to the Delta ecosystem is to continually reduce the survival and growth of listed salmonids and green sturgeon within the waterways of the action area. Fish are unable to obtain the necessary ecological benefits afforded by the natural shorelines and riparian habitat that formerly existed in the Delta due to the presence of the levees and the riprap armoring of the levee faces. The incorporation of the ETL levee vegetation policy further precludes the establishment of any riparian zone vegetation along the levee waterside face except in the circumstance where a variance to the policy can be obtained. Although the Corps has stated that they will seek a variance to revegetate riparian areas and will strive to minimize the removal of vegetation along the water's edge, the extent of this is uncertain. Furthermore, the Corps has not indicated that they will attempt to enhance and restore riparian habitat along the action area waterways to offset decades of habitat loss. This leads to a stagnant status quo of Delta habitat and ecological function of the aquatic habitats, and continues the degraded value of the aquatic and riparian habitat in the action area for the benefits of listed species. Thus, the implementation of the ETL policy and the preservation of the levee/riprapped revetment habitat of the waterside edges of the Project area, as proposed in the Project, prolongs the marginal habitat and diminished ecosystem function present in the action area and impedes the restoration of Delta habitat as called for in the Central Valley Recovery Plan (NMFS 2014).

When evaluated in the context of the whole Central Valley, the Project action area is a small proportion of all the miles of waterways and habitat available to the listed species under consideration in this Opinion. The Project does not substantially improve the available habitat, but rather maintains the status quo in the action area, although the status quo portrays a poorly functioning aquatic habitat disconnected from its terrestrial floodplains under the current environmental conditions.

NMFS observes that the migratory corridor and rearing habitat for CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon remains nominally the same as the pre-Project conditions: a highly degraded aquatic environment with minimal riparian habitat combined with extensive riprapped banks on the levee faces. The overall survival rate through the post-Project reaches in the San Joaquin River and Calaveras River may not be distinctly different than the pre-Project survival rates, although these survival rates are probably substantially lower than those seen in natural river migratory corridors.

The effects of the Project and its continued ecological conditions will not affect the rest of the Central Valley's habitat for CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon. Thus, the trajectories of the populations of these listed species will be negligibly affected by the proposed Project; neither benefited nor diminished.

2.6.6 Summary of Project Effects on CCV steelhead and sDPS Green Sturgeon Critical Habitat

Within the action area, the relevant PBFs of the designated critical habitats for listed CCV steelhead are migratory corridors and rearing habitat, and for sDPS green sturgeon the six PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on the effects of the Project described previously in this Opinion, the impacts to the designated critical habitat diminish the value of the designated critical habitat for both CCV steelhead and sDPS green sturgeon. As described in the previous sections, the critical habitat will be at best managed to maintain the status quo conditions currently seen in the action area. The quality of the current conditions of the PBFs for CCV steelhead and sDPS green sturgeon in the action area are poor compared to historical conditions (pre-levees). The habitat does not provide the functionality of the conservation values necessary for the long term survival and recovery of the species. In particular, levees, riprapping, and removal of riparian vegetation have greatly diminished the value of the aquatic habitat in the action area by decreasing rearing area, food resources via food-web degradation, and complexity and diversity of habitat forms necessary for holding and rearing (channel and bathymetry diversity). Perpetuating levee structure with armored riprap on levee surfaces coupled with a "no vegetation" policy under the current ETL criteria will continue the degraded status of the designated critical habitat into the foreseeable future.

The temporary construction impacts to designated critical habitat will negatively affect the ability of CCV steelhead and sDPS green sturgeon to use the action area as rearing habitat and as migratory corridors during the overlap of migration periods and construction as discussed previously. Effects will last for a period of several weeks, but will not permanently modify critical habitat function as noise and turbidity will end after construction ends.

The impacts of the Smith Canal and Fourteenmile Slough flood control gates will permanently create an obstruction to migration through entrapment of fish. However, the flood control structures are not expected to substantially impede overall migration through the main migratory corridors of the Calaveras River and San Joaquin River for listed species. The flood control structures are located either off of the main migratory corridors (Fourteenmile Slough) or to the edge of the main migratory corridor (Smith Canal) and protect non-spawning and non-migratory areas from flooding.

The Corps has estimated that this Project will remove approximately 20,000 lineal feet of SRA out of an estimated 25,000 lineal feet on the waterside of the levees. In addition, approximately 9 acres of woody riparian habitat will be lost. This loss occurs within the Calaveras River, the San Joaquin River, and French Camp Slough and Duck Creek sections of the action area. These areas are the primary migratory and rearing areas for listed salmonids and sDPS green sturgeon in the action area of the Project. A portion of this loss may be protected or replaced through variances to the ETL vegetation policy, allowing SRA and woody vegetation to regrow where the Corps deems it presents an acceptable risk to levee safety and integrity. However, the extent of SRA and/or woody riparian vegetation mitigation through the variances are unknown, but will supposedly have more resolution during the PED discussion prior to construction activities commence. The proposed mitigation gained through the set-back levee construction will theoretically benefit native delta species that may use flood plain habitat during their life cycles, but it will have minimal benefit to listed salmonids and sDPS green sturgeon due to its isolation from habitat currently used by these species and thus is likely to be underutilized or unavailable to these species. In a similar fashion, the mitigation bank credits purchased on the Cosumnes Floodplain Mitigation Bank will benefit native species, including any steelhead or sDPS green sturgeon subadults utilizing the mainstem channels of the Mokelumne and Cosumnes river systems, but will not benefit CCV steelhead or sDPS green sturgeon from the San Joaquin River basin. This is important since the Southern Sierra Nevada Diversity group does not inhabit the Mokelumne or Cosumnes river watersheds.

2.7 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' Opinion that the proposed action is not likely to jeopardize the continued existence of:

- CCV steelhead,
- CV spring-run Chinook salmon, or
- sDPS green sturgeon.

NMFS has concluded that the Project will affect, but not adversely modify or destroy designated critical habitat for:

- California Central Valley steelhead
- sDPS of North American green sturgeon

2.8 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this incidental take statement.

The measures described below are non-discretionary and must be undertaken by the Corps so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered in this incidental take statement (ITS). If the Corps: (1) fails to assume and implement the terms and conditions of the ITS; and/or (2) fails to require the agents of the Corps to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, the Corps and the Corps' agents or permittees must report the progress of the action and its impact on the species to NMFS as specified in this ITS (50 CFR §402.14[i][3]).

2.8.1 Amount or Extent of Take

NMFS anticipates that the proposed action will result in the incidental take of individuals from the CV spring-run Chinook salmon ESU, the CCV steelhead DPS, and the sDPS of North American green sturgeon. Incidental take associated with this action is expected to be in the form of mortality, harm, or harassment of adult and juvenile CV spring-run Chinook salmon, adult and juvenile CCV steelhead and adult and juvenile sDPS of North American green sturgeon, resulting from (1) avoidance and behavioral modification related to construction activities on the levees and associated short term turbidity events; (2) the construction of the Smith Canal flood gate structure and associated sheet pile walls between mid-July and mid-September (2 month construction period each construction season, over two summers) and the Fourteenmile Slough flood gate structures and associated sheet pile walls (mid-July through mid-September over two construction seasons), due to the generation of underwater noise associated with the process of installing sheet pile walls, concrete pilings, and concrete foundations, including noise associated with vibratory and impact pile driving; (3) the entrapment of listed fish within the channels of Fouteenmile Slough and Smith Canal gate locations during the closures of the flood control gates; (4) the predation of fish associated with the presence of the vertical sheet pile walls and the altered flow characteristics; (5) erosion and its associated turbidity related to the long term maintenance of the waterside levee faces, and (6) the removal of riparian vegetation and implementation of the Corps' ETL policy along levees impacted by this Project.

This ITS will use surrogates to establish the expected level of take due to Project actions when direct quantification of take for individuals is not possible. Surrogates are used for this ITS since it is nearly impossible to quantify the number of individuals of listed species exposed to the project's actions, but that it is certain that those individuals that are exposed will incur some level of adverse response to the exposure resulting in take as defined under the ESA. In the ITS, NMFS will explain the causal link between the surrogate and the expected response from the exposed listed species; the reason why quantifying the amount of individuals exposed to the action (*i.e.*, take) is impractical to measure; and finally, establish a clear standard as to when take is exceeded (the surrogate parameter).

1) Levee Construction Activities

San Joaquin River sections

During the levee construction actions, NMFS expects that no construction actions will occur outside of the proposed work windows of mid-July to October 31 for locations adjacent to the San Joaquin River and the Stockton DWSC. NMFS expects these species and life stages to be present during this portion of the Project:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

NMFS does not expect to see any direct mortality or morbidity of these fish due to noise generated by construction equipment and construction actions or by exposure to construction related turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of fish exposed to noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and any precipitation driven "rain on exposed soils" derived turbidity events. NMFS does not expect injury or lethal take from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of levee construction activity in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

Calaveras River and other sloughs

During the levee construction actions, NMFS expects that no construction actions will occur outside of the proposed work windows of mid-April to October 31 for locations adjacent to the Calaveras River and other sloughs identified in the Project description. NMFS expects these species and life stages to be present during this portion of the Project:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

NMFS does not expect to see any direct mortality or morbidity of these fish due to noise generated by construction equipment and construction actions or by exposure to construction related turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of fish exposed to noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and any precipitation driven "rain on exposed soils" derived turbidity events. NMFS does not expect injury or lethal take from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of levee construction activity in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2) Flood Gate construction

During the two years of construction that it will take to complete the installation of the flood control gates, NMFS expects these species and life stages to be present during the pile driving portion of the construction window from mid-July to mid-September for the sheet pile walls and gate:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

Incidental take of adult CCV steelhead, and juvenile and adult sDPS green sturgeon is expected to occur during the 2-month construction period occurring between mid-July and mid-September as a result of exposure to the noise generated by pile driving activities. Quantification of the number of fish exposed to the pile driving associated noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise and turbidity. Only the level of acoustic noise generated during the construction phases of the two flood control gates can be accurately and consistently measured, thus providing a quantifiable metric for determining incidental take of listed fish. Therefore, the measurement of acoustic noise generated during the construction phase, and in particular the vibratory and impact pile driving of the sheet pile sections and concrete piles described in the proposed Project, will serve as a physically measurable surrogate for the incidental take of listed fish species. NMFS assumes that the Project proponent will adhere to the Project description provided for the purposes of the section 7 consultation, and will not depart from that description in any meaningful or demonstrable way.

The analysis of the effects of the proposed LSJRFS anticipates that the installation of the flood control gates will use 24-inch wide sheet piles and 24-inch diameter concrete piles for construction and that 10 sheet piles will be driven per work day and 5 concrete piles will be driven per work day. NMFS also estimated that it will take 12 minutes of vibratory hammer pile driving and 5 minutes of impact hammer driving to set each sheet pile to the correct depth and load bearing resistance. NMFS estimated that it will take 20 minutes per concrete pile to drive them to the appropriate tip depth and resistance. The number, size, and material of the pilings will affect the amount of sound energy generated during the driving of the pilings that was analyzed for this Project. Different methodologies or types of pile driving equipment will alter the characteristics of the acoustic noise generated during the installation of the pilings, which in turn affects the physiological and behavioral response of the exposed receptors (*i.e.,* listed fish species) present in the vicinity of the construction activities. Based on the effects analysis conducted for this consultation, and using the data from the CalTrans compendium for steel sheet piles and an impact hammer to populate the NMFS spreadsheet calculator, the amount of generated sound associated with the pile driving actions shall not exceed 206 dB peak at 9 meters (29.5 feet) from the sheet pile being driven at any time, 187 dB $SEL_{accumulated}$ at 710 meters (2,329 feet); 183 dB $SEL_{accumulated}$ at 1000 meters (3,281 feet), and a value of 150 dB RMS as measured at 4,642 meters (15,230 feet) from the pile at any time. For the 24-inch concrete piles driven with the impact hammer, measured sound shall not exceed 206 dB peak at 1 meter from the pile, 187 dB $SEL_{accumulated}$ at 46 meters (151 feet); 183 dB $SEL_{accumulated}$ at 46 meters (151 feet), and a value of 150 dB RMS as measured at 215 meters (705 feet).

Using the values for vibratory hammers (Hastings 2010), the calculated cumulative injury (SEL) noise energy thresholds for non-auditory tissue damage indicate that juvenile sDPS green sturgeon would have to be closer than 1.3 meters (215 dB $SEL_{accumulated}$) to encounter cumulative injury effects for fish larger than 10 grams but less than 102 grams (typical of the juvenile green sturgeon that might be present in the Delta). For adult steelhead or green sturgeon, or fish > 102 grams, a sound exposure level > 234 dB $SEL_{accumulated}$) is needed for both auditory and non-auditory tissue damage. Using the NMFS calculator, vibratory hammers driving 24-inch steel AZ sheet piles should not exceed 201.6 dB $SEL_{accumulated}$ at 10 meters, thus 215 dB $SEL_{accumulated}$ is reached at 1.3 meters (4.3 feet) and 234 dB $SEL_{accumulated}$ is reached at 3 inches.

If any of these proxies (derived from the NMFS spreadsheet values) are exceeded, the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

3) Entrapment of listed Fish due to the operation of flood control gates

NMFS expects that during the operations of the flood gate structures, closures for water elevations greater than +8.0 feet NAVD88 will occur only during the period from November 1 through April 30. NMFS expects these species and life stages to be present during this portion of the Project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to the operations of the Smith Canal flood control structure. It is unlikely that listed species will be exposed to the operations of the Fourteenmile Slough Flood control structure, but incidental take at that facility will be accounted for by using the same surrogates for both structures. NMFS expects that take will be in the form of mortality and morbidity resulting from entrapment of listed fish behind the closed gate. Trapped fish will have an elevated vulnerability to predation and exposure to degraded water quality in the waterbodies upstream of the closed gate structures. Quantification of the number of individual fish exposed to predation and degraded water quality is not currently possible with available monitoring data. Gate closures will only occur for high tides or water elevations exceeding +8.0 feet NAVD88 or required maintenance. Therefore the frequency of gate operations is defined by the water elevation and will be used as a surrogate for the exposure of fish to entrapment behind the gates. Operations of the gates at water elevations below +8 feet NAVD (except for maintenance purposes) will result in more frequent operations of the flood gate structure which will result in more opportunities to entrap fish. NMFS will consider this as creating conditions that have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

4) Predation of listed fish due to the altered hydrodynamics of water flowing through the flood control gates and the presence of vertical sheet pile walls

NMFS expects that the presence of the flood gate structures will create altered flow conditions related to the narrow width of the flood control structure gates. This will enhance predation upon listed fish species. These conditions will be present throughout the year and are created by daily tidal flows. NMFS expects these species and life stages to be present in the waters adjacent to the Project structures:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to the operations of the Smith Canal flood control structure. It is unlikely that listed species will be exposed to the operations of the Fourteenmile Slough Flood control structure, but incidental take at that facility will be accounted for by using the same rational for surrogates as the Smith Canal structure. NMFS expects that take will be in the form of mortality and morbidity resulting from predation of listed fish moving through the open gate or along the face of the flood structure. Listed fish will have an elevated vulnerability to predation due to the hydrodynamic conditions created by the open gate structures and the vertical sheet pile wall structure placed into the open water environment, both of which are expected to attract predators. Quantification of the number of fish exposed to predation is not currently possible with available monitoring data. The level of take is associated with the creation of a high velocity flow through the narrow gate opening, currently designed to be approximately 50 feet wide. The width of the gate is an integral factor in determining the velocity of the water flowing through the open gate, as well as the water elevation differential between the two sides of the flood structure. If the gate opening is made narrower, the velocity increases, thereby creating more adverse conditions for listed fish passing through it. Higher velocities create more turbulence, eddies, and disorientation to the fish caught in the high velocity jet, allowing them to become easier targets for predators. A wider gate opening will have the opposite effect, reducing the velocity of the flow. NMFS will consider that any changes to the gate opening that will make it narrower and thus increases the velocity of water moving through the open gate as exceeding anticipated incidental take as analyzed in this Opinion. The level of take associated with placing a vertical structure in the channel (*i.e.*, the sheet pile wall) is related to the linear length of the wall, and the holding and hiding habitat that it can provide to predators residing in the area. Increasing the length of the wall will increase the potential predator holding habitat. Conversely, shortening the length of the wall will reduce the predator holding habitat. NMFS will consider that any changes to the length of the wall that demonstrably increases its linear length (currently designed to be approximately 800 feet for Smith Canal and 300 feet for Fourteenmile Slough) will exceed the anticipated incidental take of listed fish as assessed in this Opinion.

5) <u>Turbidity events related to erosion from post-construction locations</u>

NMFS expects that during the life time of the Project's levee modifications that exposure to turbidity events will occur during precipitation events related to erosion from the waterside faces of the levees. Post-construction maintenance is considered to be part of the discretionary actions retained by the Corps through issuance of its operations and maintenance manuals to the local non-Federal sponsors of the Project. NMFS expects these species and life stages to be present during the Project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to some proportion of the post-construction levees within the Project's action area during one or more life history phases, such as juvenile rearing, adult upstream migration, and juvenile downstream migration. NMFS does not expect to see any direct mortality or morbidity of these fish due to post-construction erosion and its related increase in local turbidity. Take will be in the form of harassment and behavioral modifications of rearing and migrating fish. Quantification of the number of individual fish exposed to post-construction turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during their life history phases may be exposed to precipitation driven "rain on exposed soils" derived turbidity events when fish presence and precipitation events co-occur. NMFS expects a low level of injury or lethal take to occur from these exposures. Observations of erratically behaving fish, or more than 3 freshly dead or moribund listed fish within 500 feet of an erosive post-construction site in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels. Turbidity levels that result in injury or mortality are indicative of non-compliance with the Corps issued operations and maintenance manuals to the non-Federal sponsors of the Project.

6) Removal of riparian vegetation and implementation of the Corps' ETL policy along levees impacted by this Project

NMFS expects that during the life time of the Project's levee modifications that exposure to effects from vegetation removal policies will occur as fish move through the action area along migratory corridors adjacent to the waterside faces of the levees. Removal of riparian vegetation prior to construction activities and continued loss of riparian vegetation functions due to the implementation of the Corps' ETL "no vegetation" policy is considered to be part of the discretionary actions retained by the Corps. NMFS expects these species and life stages to be present during the ongoing Project maintenance operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above will be exposed to some proportion of the post-construction levee ETL vegetation policy within the Project's action area during one or more life history phases, such as juvenile rearing, adult upstream migration, and juvenile downstream migration. NMFS expects that take will be in the form of harm, harassment, morbidity, and mortality resulting from lack of cover along the shoreline, lack of refugia from predators and high flows, lack of functional food webs resulting in decreased growth and physiological condition, and increased predation of listed fish moving through the nearshore habitat. Quantification of the number of individual fish exposed to the degraded riparian habitat is not currently possible with available monitoring data. All fish passing through or otherwise present in these affected areas will be exposed to the lack of riparian vegetation along the shorelines and the environmental impacts previously described in the effects analysis. Therefore NMFS will use the lineal feet of removed SRA vegetation and the lost woody riparian vegetation area as surrogates for the incidental take of listed fish species. The Corps has projected that approximately 20,000 lineal feet of SRA vegetation and 9 acres of woody riparian vegetation will be removed for the Project. If more than the proposed 20,000 linear feet of SRA vegetation, or more than 9 acres of woody riparian vegetation are removed, then NMFS will consider the incidental take of listed species affected by the Project to have been exceeded.

2.8.2 Effect of the Take

In the Opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.8.3 Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1. Measures shall be taken to ensure that implementation of the Lower San Joaquin Feasibility Study Recommended Plan minimizes, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead, and green sturgeon that are subject to this consultation.

2. Measures shall be taken to maintain, monitor, provide compensatory mitigation and adaptively manage all conservation and compensatory mitigation measures to ensure their effectiveness.

3. Measures shall be taken, when feasible and practicable, to minimize the impacts of construction by implementing the Corps proposed conservation measures and any other required mitigation measures that avoid and minimize adverse effects on growth and survival conditions for salmonids, and the sDPS of North American green sturgeon.

4. Measures shall be taken to ensure that the Recommended Plan is implemented consistent with the biological assessment and this Opinion.

5. Measures shall be taken to minimize project impacts to riparian habitat within the construction footprint of the Recommended Plan for the protection of fish habitat features that are subject of this Opinion to the maximum extent feasible and consistent with public safety requirements.

6. Measures shall be taken to minimize, reduce, or avoid construction impacts relating to turbidity and noise.

7. Measures shall be taken to refine existing conditions data in the Recommended Plan construction footprint during PED.

8. Measures shall be taken to develop post construction remediation/mitigation for lost riparian function.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this incidental take statement (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1: *"Measures shall be taken to ensure that implementation of the Lower San Joaquin Feasibility Study Recommended Plan minimizes, to the maximum extent practicable, any adverse effects on federally listed salmon, steelhead, and green sturgeon that are subject to this consultation."*

a. The Corps shall continue to coordinate with NMFS, USFWS, CVRWQCP, CDFW and other agencies as the Recommended Plan designs and the operational criteria are further developed during PED.

b. The Corps shall coordinate with NMFS during PED as the Recommended Plan is designed to ensure conservation measures are incorporated to the extent practicable and feasible and as described in the BA.

c. The Corps shall consider and apply, as necessary, the California Levee Vegetation Research Program Synthesis of Levee Vegetation Research Results (2007-2014), when conducting vegetation risk assessments as the Recommended Plan designs are further developed during PED.

2. The following terms and conditions implement reasonable and prudent measure 2: *"Measures shall be taken to maintain, monitor, provide compensatory mitigation and adaptively manage all conservation and compensatory mitigation measures to ensure their effectiveness."*

   a. The Corps shall develop a habitat mitigation and monitoring plan (HMMP) with an overall goal of ensuring that project impacts on listed species are fully mitigated and which identifies target levels of function to be met and tools for measurement.

   b. The HMMP shall include specific goals and objectives and a clear strategy for maintaining the long-term conservation and mitigation elements for the life of the project.

   c. The Corps shall coordinate with NMFS prior to the onset of any riverside construction, including the placement of in-water revetment or removal of riparian vegetation.

   d. The Corps shall monitor the HMMP for 5 years following construction and shall update the project O&M manual, as appropriate, to ensure that the project, including the conservation measures, is maintained by the local sponsor for the life of the Project.

   e. The HMMP shall include a compensatory mitigation accounting plan to track and document compensatory mitigation performance in relation to the targets identified in the HMMP. The Corps shall require that the maintaining agency be responsible for tracking and documenting mitigation performance once the project is turned over.

   f. The Corps shall include as part of the HMMP, a section with special emphasis on the riparian corridor with the overall goal of documenting the ecological success and the conditions of the corridor within the construction footprint and within the on-site mitigation lands. The Corps shall coordinate the HMMP with NMFS prior to construction of the Recommended Plan.

g. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period as described in the HMMP.

h. The Corps shall host an annual meeting and issue annual reports for five years following completion of Project construction. The purpose is to ensure that conservation features of the Project are developing consistent with the HMMP.

3. The following terms and conditions implement reasonable and prudent measure 3: *"Measures shall be taken, when feasible and practicable, to minimize the impacts of construction by implementing the Corps proposed conservation measures and any other required mitigation measures that avoid and minimize adverse effects on growth and survival conditions for salmonids, and the sDPS of North American green sturgeon."*

    a. The Corps shall ensure that for salmon, steelhead, and green sturgeon, the adverse effects at each seasonal water surface elevation are fully offset through compensatory conservation measures in or adjacent to the project area or through the purchase of credits at a NMFS approved conservation bank (as described in the BA).

    b. The Corps shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.

    c. The Corps shall ensure that the planting of native vegetation will occur as described in the Corps 2015 BA and within this Opinion. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

    d. The Corps shall, for conservation banking actions, provide mitigation at a 3:1 ratio. This is mainly because the mitigation will occur offsite. This includes habitat improvements adjacent to the Project area, or through conservation bank credit purchase as described in the Corps Biological Assessment Terrestrial and Aquatic Species San Joaquin River Basin Lower San Joaquin River CA Interim Feasibility Study as received by email on November 9, 2015.

4. The following terms and conditions implement reasonable and prudent measure 4: *"Measures shall be taken to ensure that the Recommended Plan is implemented consistent with the biological assessment and this Opinion."*

    a. The Corps is responsible for ensuring that all requirements of the Opinion are met.

    b. The Corps shall ensure the contractor plans and specifications are consistent with the requirements of the Opinion.

c. The Corps shall provide a copy of this Opinion, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all requirements and obligations included in these documents and to educate and inform all other contractors involved in the Project as to the requirements of this Opinion. A notification that contractors have been supplied with this information will be provided to the reporting address below.

Assistant Regional Administrator
California Central Valley Area Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

d. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to Federally-listed fish, their critical habitat, an overview of the life-history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this Opinion. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.

5. The following terms and conditions implement reasonable and prudent measure 5: *"Measures shall be taken to minimize project impacts to riparian habitat within the construction footprint of the Recommended Plan for the protection of fish habitat features that are subject of this Opinion to the maximum extent feasible and consistent with public safety requirements"*

a. This Opinion is based on the Recommended Plan, which includes assumptions about the potential suitability of the levees included in the Recommended Plan for a variance to ETL 1110-20583 for vegetation. The Recommended Plan also includes commitments to conduct additional engineering investigations during PED to specifically address variance possibilities. The Corps shall provide updates on the status of these engineering investigations and conclusions regarding the suitability of Recommended Plan levees for an ETL 1110-2-583 vegetation variance. If technically feasible, the Corps shall obtain a vegetation variance to allow for the protection of existing vegetation in place and the planting of new low-risk vegetation on the lower 1/3 slope of the levee system.

b. The Corps shall, when developing riparian mitigation options, apply the following mitigation hierarchy: (1) onsite planting (along the levee section where riparian vegetation is removed) within anadromous habitat, and within the lower 1/3 of the levee slope; (2) within project area, but not along the specific levee section where riparian vegetation is removed, and within anadromous habitat, within the lower 1/3 of the levee slope; (3) within the project area and within anadromous habitat, but in areas that are not affected by flood risk reduction actions; (4) offsite at NMFS approved conservation banks.

6. The following terms and conditions implement reasonable and prudent measure 6: *"Measures shall be taken that minimize, reduce, or avoid construction impacts relating to turbidity and noise in order to reduce impacts to listed species."*

   a. To prevent sediments from escaping the site and entering water systems where they could adversely affect listed fish species and their habitat, sediment control measures would be installed around the construction sites. The contractor shall be required to obtain a National Pollution Discharge Elimination System permit from the Regional Water Quality Control Board, Central Valley Region. As part of the permit, the contractor shall be required to prepare a Storm Water Pollution Prevention Plan prior to initiating construction activities, identifying BMPs to be used to avoid or minimize any adverse effects during construction to surface waters.

   b. The following BMPs shall be incorporated into the Project to reduce, minimize or avoid turbidity associated with construction activities:

      i. Implement appropriate measures, such as straw wattles and silt fencing, to prevent debris, soil, rock, or other material from entering the water.
      ii. Use a water truck or other appropriate measures to control dust on haul roads, construction areas, and stockpiles. Application of water would not be excessive or result in runoff into storm drains.
      iii. Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, additional erosion and sedimentation control measures would be implemented.
      iv. Maintain sediment and erosion control measures during construction. Inspect the control measures before, during, and after a rain event.
      v. Train construction workers in storm water pollution prevention practices.
      vi. Revegetate disturbed areas in a timely manner to control erosion.
      vii. If vegetation is not growing sufficiently it shall be replanted or provided with irrigation if necessary.
      viii. Erosion BMPs will be monitored for effectiveness during the active construction window and during periods of inactivity following the active construction window for effectiveness, particularly during the rainy season.

   c. To minimize, reduce, or avoid excessive noise levels associated with construction on the Calaveras River the Corps shall:

      i. Minimize activities on the Calaveras River if a hydraulic connection exists between the lower and upper reaches either due to normal flows or rain events.
      ii. If a hydraulic connection does not exist then normal construction activities can resume.

iii. If construction is underway during a hydraulic connection between the lower and upper reaches, noise levels shall be monitored and shall not exceed 150 dB (RMS) within the river channel.

d. To minimize, reduce, or avoid excessive noise levels associated with pile driving for the flood control gates and levee flood wall the Corps shall:

i. The Corps will follow NMFS' recommended sound criteria for pile driving activities described in the Opinion and minimize and reduce the extent of the sound field to reduce injury and mortality to exposed fish in the Project area. For impact pile driving hammers, the Corps shall use a peak sound pressure level of 206 decibels (dB) and an accumulated sound exposure level (SEL) of 187 dB as thresholds for injury to fish. For fish less than 2 g, the accumulated SEL threshold is reduced to 183 dB.

ii. For vibratory hammers, the Corps shall use the following thresholds for injury:

- <u>Non-auditory tissue damage</u>
  - Mass $\leq$ 0.6 g = 191 dB-SELaccumulated
  - For fish between 0.6 and 102 g mass, cumulative SEL = 195.28 + 19.28*log10(mass)
  - Mass $\geq$ 102 g = 234 db-SELaccumulated

- <u>Auditory tissue damage</u>
  - Hearing generalists (e.g., salmonids): > 234 dB-SELaccumulated
  - Hearing specialists (e.g., carp): 222 dB-SELaccumulated

- <u>Temporary threshold shift (hearing loss)</u>
  - Hearing generalists: 234 dB-SELaccumulated
  - Hearing specialists: 185 dB-SELaccumulated

iii. The Corps shall minimize the use of impact hammers during pile driving actions. Impact hammers shall only be used on the final portions of the pile driving action to set the concrete piles or sheet piles to final tip depth and load bearing criteria as required by the engineering designs.

iv. The Corps shall use the vibratory hammer to the greatest extent possible during pile driving actions. The Corps shall start driving the concrete piles and sheet piles initially with the vibratory hammer, starting slowly and gradually increasing intensity to reduce effects to fish in the surrounding aquatic habitat. The Corps may switch to the impact hammer to achieve final tip depth and load bearing resistance if necessary if the vibratory hammer is insufficient to achieve these parameters.

v. The Corps shall monitor noise generation in the water surrounding the pile driving activity (10m away, 1m deep as reference location for compliance). These data will be used to ensure that sound pressure levels are compatible with the assumptions made for calculations describing the range of noise effects and that noise levels do not exceed criteria.

7. The following terms and conditions implement reasonable and prudent measure 7: "*Measures shall be taken to refine existing conditions data in the Recommended Plan construction footprint during PED to minimize impacts to listed species.*"

    a. The Corps shall develop a database similar to the 2007 Sacramento River Bank Protection Project Revetment Database (Corps 2007). The database shall be used in the Recommended Plan construction footprint to refine existing conditions data and determine any deficits as measured using tools and targets outlined in the HMMP.

2.9 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1. The Corps should integrate the 2017 California Central Valley Flood Protection Plan's Conservation Strategy into all flood risk reduction projects they authorize, fund, or carry out.
2. The Corps should prioritize and continue to support flood management actions that set levees back from rivers and in places where this is not technically feasible, repair in place actions should pursue land-side levee repairs instead of waterside repairs.
3. The Corps should consult with NMFS in the review of ETL variances for future projects that require ETL compliance.
4. The Corps should investigate ETL vegetation variances for all flood management actions that are adjacent to anadromous fish habitat.
5. The Corps should sponsor an independently facilitated workshop that includes NMFS, USFWS, CDFW, DWR, local maintainers such as Sacramento Area Flood Control Agency, and the authors of the Synthesis of Levee Vegetation Research Results (2007-2014) to discuss the conclusions of this report and how local tree risk models that incorporate the best available science can be used in future risk assessments for levee repair programs.
6. The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Lower San Joaquin River Feasibility Study Project.
7. The Corps should encourage cost share sponsors and applicants to develop floodplain and riparian corridor enhancement plans as part of their projects.
8. The Corps should seek out opportunities for setback levee and other flood management activities that promote overall riverine system restoration.

9. The Corps should support and promote aquatic and riparian habitat restoration within the San Joaquin River, Delta and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.
10. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.10 Reinitiation of Consultation

This concludes formal consultation for Lower San Joaquin River Feasibility Study. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) the amount or extent of incidental taking specified in the incidental take statement is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this Opinion, (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this Opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

Specifically, the Corps shall reinitiate consultation if a variance is not granted or if a variance is granted that does not meet the minimum standards that are described in the proposed action of the BA and this Opinion.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT CONSULTATION

Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect Essential Fish Habitat (EFH). The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. For the purposes of interpreting the definition of EFH, "waters" includes aquatic areas and their associated physical, chemical, and biological properties that are used by fish, and may include areas historically used by fish where appropriate; "substrate" includes sediment, hard bottom, structures underlying the waters, and associated biological communities; "necessary" means habitat required to support a sustainable fishery and a healthy ecosystem; and, "spawning, breeding, feeding, or growth to maturity" covers all habitat types used by a species throughout its life cycle.

This analysis is based, in part, on the EFH assessment provided by the United States Army Corps of Engineers (Corps) and descriptions of EFH for Pacific coast salmon as described in Amendment 18 to the Pacific Coast Salmon Plan (Pacific Fisheries Management Council [PFMC], 2014) contained in the fishery management plans (FMP) developed by the PFMC and approved by the Secretary of Commerce.

The proposed Project area is within the region identified as EFH for Pacific salmon in Amendment 18 of the Pacific Coast Salmon FMP. The Corps is receiving this consultation under the MSA for potential impacts to the EFH of Pacific salmon as a result of implementing the Lower San Joaquin Feasibility Study (Project) near the city of Stockton in USGS Hydrologic Unit Codes (HUCs) 1804003 (San Joaquin Delta).

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 18 to the Pacific Coast Salmon FMP (PFMC 2014). Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998). Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*), Central Valley spring-run Chinook salmon (*O. tshawytscha*), and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Salmon Plan that occur in the USGS HUCs described in Amendment 18.

3.1 Essential Fish Habitat Affected by the Project

he geographic extent of freshwater EFH is identified as all water bodies currently or historically occupied by Council-managed salmon as described in Amendment 18 of the Pacific Coast Salmon Plan. In the estuarine and marine areas, salmon EFH extends from the extreme high tide line in nearshore and tidal submerged environments within state territorial waters out to the full extent of the Exclusive Economic Zone (EEZ) (200 nautical miles or 370.4 km) offshore of Washington, Oregon, and California north of Point Conception. The proposed Project occurs in the area identified as "freshwater EFH"; as it is above the tidal influence where the salinity is above 0.5 parts per thousand.

The implementing regulations for the EFH provisions of the MSA (50 CFR part 600) recommend that the FMPs include specific types or areas of habitat within EFH as "habitat areas of particular concern" (HAPC) based on one or more of the following considerations: (1) the importance of the ecological function provided by the habitat; (2) the extent to which the habitat is sensitive to human-induced environmental degradation; (3) whether, and to what extent, development activities are, or will be, stressing the habitat type; and (4) the rarity of the habitat type. Based on these considerations, the Council designated five HAPCs: (1) complex channels and floodplain habitats; (2) thermal refugia; (3) spawning habitat; (4) estuaries; and (5) marine and estuarine SAV. No HAPCs occur in the Project area or will be affected by the Project.

3.2 Adverse Effects on Essential Fish Habitat

The proposed Project is considered to have multiple nonfishing activities that affect EFH for Pacific salmon as described in Amendment 18 to the Pacific Coast Salmon FMP. The following actions are considered to have potential adverse effects on the freshwater EFH in the action area of the Project:

1) *Activities causing high intensity underwater acoustic or pressure waves* – The proposed Project entails driving a substantial number of steel sheet piles and concrete piles over the course of two work years to construct the Smith Canal and Fourteenmile Slough Flood control gates and their associated sheet pile walls. The pile driving actions will use both impact pile driving hammers as well as vibratory pile driving hammers. The effects of these actions on listed salmonids and sDPS green sturgeon has already been described in section 2.4.1.1 of the Opinion. NMFS expects that a portion of the pile driving actions undertaken for the Smith Canal gate structure will overlap with the migration of adult fall-run Chinook salmon, an unlisted ESU, into the Calaveras and San Joaquin rivers during the fall. Fish exposed to the impact pile driving hammer are expected to be exposed to sound levels that will exceed the threshold for injury or mortality over a significant proportion of the adjoining San Joaquin River channel. Injuries are expected to the soft tissues surrounding the swim bladder, bruising and hemorrhaging of organs, damage to auditory tissues, and behavioral avoidance and alterations. Some of these injuries may rise to the level of mortality, depending on their severity.

2) *Bank Stabilization and Protection* – The proposed Project has components that will entail bank stabilization and protection activities in the action area which includes freshwater EFH. The alteration of riverine and estuarine habitat from bank and shoreline stabilization, and protection from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitat. Human activities removing riparian vegetation, armoring, relocating, straightening and confining stream channels and along tidal and estuarine shorelines influences the extent and magnitude of stream bank erosion and down-cutting in the channel. In addition, these actions have reduced hydrological connectivity and availability of off-channel habitat and floodplain interaction. Armoring of shorelines to prevent erosion and maintain or create shoreline real estate simplifies habitats, reduces the amount of intertidal habitat, and affects nearshore processes and the ecology of a myriad of species (Williams and Thom 2001).

3) *Flood Control Maintenance* - The protection of riverine and estuarine communities from flooding events can result in varying degrees of change in the physical, chemical, and biological characteristics of existing shoreline and riparian habitats. Managing flood flows with flood control structures such as levees can disconnect a river from its floodplain eliminating off-channel habitat important for salmon. Floodplains serve as a natural buffer to changes in water flow: retaining water during periods of higher flow and releasing it from the water table during reduced flows. These areas are typically well vegetated, lowering water temperatures, regulating nutrient flow and removing toxins. Juvenile salmon use these off channel areas because their

reduced flows, greater habitat complexity and shelter from predators may increase growth rates and their chance of survival. Artificial flood control structures also have similar effects on aquatic habitat, as does the efforts to stabilize banks and remove woody debris. The function of natural stream channels and associated riparian areas and the effects of flood control structures such as levees has been discussed in section 2.4.1.3 of this Opinion.

4) *Compensatory Mitigation Projects* – Part of the proposed Project includes the construction of 7,000 feet of setback levee along Fourteenmile Slough as part of the mitigation for the impacts of the Project on riparian areas and nearshore habitat. The creation of the setback levee is a significant construction activity that may have short term negative impacts to the local environment and freshwater EFH. Possible impacts include 1) localized nonpoint source pollution from substances like petroleum products, sediment, or nutrients, 2) interference with migration or feeding, 3) direct effects like crushing from equipment operation or materials placement, and 5) fish stranding from poorly draining floodplains. These specific impacts should be addressed as part of the planning process.

5) *Wetland and Floodplain Alterations* – Pacific salmon evolved in the Central Valley with an extensive and complex floodplain adjacent to the river, with many channels and sloughs dissecting the plain and extensive wetlands and marshes fringing the waterways. Most of these floodplains and associated wetlands and marshes have been lost to anthropogenic causes. Floodplains, including side channels, and wetlands throughout the region have been converted through diking, draining, and filling to create agricultural fields, livestock pasture, areas for ports, cities, and industrial lands. The construction of dikes, levees, roads, and other structural development in the floodplain that confine the river have further effects on salmon habitat (PFMC 2014). As described in Amendment 18, a river confined by adjacent development and/or flood control and erosion control structures, can no longer move across the floodplain and support the natural processes that 1) maintain floodplain connectivity and fish access that provide velocity refugia for juvenile salmon during high flows; 2) reduce flow velocities that reduce streambed erosion, channel incision, and spawning redd scour; 3) create side channels and off-channel areas that shelter rearing juvenile salmon; 4) allow fine sediment deposition on the floodplain and sediment sorting in the channel that enhance the substrate suitability for spawning salmon; 5) maintain riparian vegetation patterns that provide shade, large wood, and prey items to the channel; 6) provide the recruitment of large wood and spawning gravels to the channel; 7) create conditions that support hyporheic flow pathways that provide thermal refugia during low water periods; and 8) contribute to the nutrient regime and food web that support rearing and migrating juvenile salmon in the associated mainstem river channels.

3.3 Essential Fish Habitat Conservation Recommendations

The Corps should implement the following conservation measures to offset the adverse effects described in section 3.2 above. In order to avoid or minimize the effects to EFH, NMFS recommends the following conservation measures described in Amendment 18 to the Pacific Coast Salmon FMP:

1) *Activities causing high intensity underwater acoustic or pressure waves* – the Corps should:

- When possible, avoid driving piles when salmon are present, especially the younger life stages and spawning adults.
- Avoid driving piles with an impact hammer when salmon or their prey are present. Alternatives include vibratory hammers or press-in pile drivers.
- In cases where an impact hammer must be used, drive the piles as far as possible with a vibratory or other method that produces lower levels of sound before using an impact hammer.
- When driving piles in intertidal or shallow subtidal areas, do so during periods of low tide. Sound does not propagate as well in shallow water as it does in deep water.
- Implement measures to attenuate the sound. Such measures include the use of a bubble curtain or a dewatered pile sleeve or coffer dam. Monitor the sound levels during pile driving to ensure that the attenuation measures are functioning as expected.
- Where tidal currents can be strong, drive the piles when the current is reduced (i.e., centered on slack current) to minimize the number of fish exposed to adverse levels of underwater sound. Strong currents can bring more fish into close proximity to the pile than would a weak current.
- Monitor, and report back to NMFS, the sound levels during pile driving to verify that the assumptions in the analysis were correct and to ensure that any attenuation device is properly functioning. Develop the monitoring and reporting protocols according to guidance provided by the Fisheries Hydroaccoustic Working Group (FHWG (2013)). The report should be provided to NMFS according to the individual project requirements, but no later than 60 days after completion of the pile driving.
- Implement terms and conditions 6 (c, d) to reduce noise related impacts from the section 7 Opinion for this Project.

2) *Bank Stabilization and Protection*

- Minimize the loss of riparian habitats as much as possible.
- Bank erosion control should use vegetation methods or "soft" approaches (such as beach nourishment, vegetative plantings, and placement of LWD) to shoreline modifications whenever feasible. Hard bank protection should be a last resort and the following options should be explored (tree revetments, stream flow deflectors, and vegetative riprap.
- Re-vegetate sites to resemble the natural ecosystem community.
- Replace in-stream fish habitat by providing root wads, deflector logs, boulders, rock weirs and by planting shaded riverine aquatic cover vegetation.
- Use an adaptive management plan with ecological indicators to oversee monitoring and ensure mitigation objectives are met. Take corrective action as needed.
- Implement term and conditions 1(c), 2 (all), 3 (b, c, d) 5(a) and 8 (all) from the section 7 Opinion for this Project.

3) *Flood Control Maintenance*

Include the conservation measures from the *Bank Stabilization and Protection* section of the Opinion and:

- Retain trees and other shaded vegetation along earthen levees and outside levee toe.
- Ensure adequate inundation time for floodplain habitat that activates and enhances near-shore habitat for juvenile salmon.
- Reconnect wetlands and floodplains to channel/tides.

4) *Compensatory Mitigation Projects*

- Develop and conduct compensatory mitigation activities on a watershed-scale.
- Design compensatory mitigation activities as an experiment, using adaptive management to determine Project success and modify until the success criteria are achieved.
- Protect habitat-forming processes (e.g., riparian community succession, bedload transport, runoff pattern) that maintain the biophysical structure and function of aquatic ecosystems.
- Use BMPs to minimize and avoid all potential impacts to EFH during compensatory mitigation activities. This conservation measure requires the use of BMPs during compensatory activities to reduce impacts from Project implementation. BMPs should include, but are not limited to, the following:
    - Measures to protect the water column such as turbidity curtains, hay bales, and erosion mats should be used.
    - Staging areas should be planned in advance and kept to a minimum size.
    - Buffer areas around sensitive resources such as rare plants, archeological sites, etc., should be flagged and avoided.
    - Invasive species should be removed from the proposed action area prior to commencement of work. Only native plant species should be replanted.
    - Ingress/egress areas should be established prior to compensatory activities to minimize adverse impacts from Project implementation.

- Avoid compensatory work during critical fish windows to reduce direct impacts to important ecological functions such as spawning, nursery, and migration. This conservation measure requires scheduling projects when managed species are not expected in the area. These periods should be determined prior to Project implementation to reduce or avoid any potential impacts.
- Provide adequate training and education to volunteers and project contractors to ensure minimal impact to the compensatory site. Volunteers should be trained in the use of low-impact techniques for planting, equipment handling, and any other activities associated with the compensatory.
- Conduct monitoring before, during, and after Project implementation to ensure compliance with Project design and compensatory criteria. If immediate post-construction monitoring reveals that unavoidable impacts to EFH have occurred, appropriate coordination with NOAA Fisheries should occur to determine appropriate response measures, possibly including mitigation.

- Mitigate fully any unavoidable damage to EFH during Project implementation and accomplish within reasonable period of time after the impacts occurred.

5) *Pesticide Use*

The conservation measure implemented will vary depending on the specific pesticide being applied, the species and life stage in the area, and the time of year. In general, they include:

- Avoid the use of pesticides near aquatic habitats, if possible.
- Use less toxic alternatives to pesticides such as mechanical mowing or hand operated tools.
- Establish a minimum no-application buffer width.
- Maintain healthy riparian zones alongside salmon-bearing waters.
- Restrict applications under certain environmental conditions, such as during periods of high wind, rain, or wet soils.

6) *Wetland and Floodplain Alterations*

- Minimize alteration of floodplains and wetlands in areas of salmon EFH.
- Determine cumulative effects of all past and current floodplain and wetland alterations before planning activities that further alter wetlands and floodplains.
- Promote awareness and use of the USDA's wetland and conservation reserve programs to conserve and restore wetland and floodplain habitat.
- Promote compensatory of degraded floodplains and wetlands, including in part reconnecting rivers with their associated floodplains and wetlands and invasive species management.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, mitigating, or offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, NMFS ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the Opinion addresses these DQA components, documents compliance with the DQA, and certifies that this Opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this Opinion are the Corps. Other interested users could include SJRFCA, USFWS, CDFW, or DWR. Individual copies of this Opinion were provided to the Corps. This Opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this Opinion and EFH consultation contain more background on information sources and quality.
Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA [*and MSA implementation, if applicable*], and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCRO-2019-00226

October 18, 2019

Chandra Jenkins
Senior Project Manager
California Delta Section
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for the Lower San Joaquin River Feasibility Study – Smith Canal Gate (SPK-2016-00037)

Dear Ms. Jenkins:

Thank you for your letter of March 29, 2019, requesting reinitiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Lower San Joaquin River Feasibility Study – Smith Canal Gate.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)) for this action. NMFS' review concludes that the project will adversely affect the EFH of Pacific Coast Salmon.

Based on the best available scientific and commercial information, the biological opinion concludes that the proposed project is not likely to jeopardize the continued existence of the federally listed threatened Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), threatened California Central Valley steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened southern DPS of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

Please contact Monica Gutierrez at (916) 930-3657, or via email at Monica.Gutierrez@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Maria Rea

Maria Rea
Assistant Regional Administrator
California Central Valley Office

Enclosure

cc: To the file 151422-WCR2018-SA00483

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response and Fish and Wildlife Coordination Act Recommendations for

Lower San Joaquin River Feasibility Study – Smith Canal Gate

National Marine Fisheries Service Consultation Number: WCRO-2019-00226

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central Valley spring-run Chinook Salmon ESU (*O. tshawytscha*)	Threatened	Yes	No	N/A (Does not occur within the action area for this species)	N/A (Does not occur within the action area for this species)
California Central Valley steelhead Distinct Population Segment (DPS (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Maria Rea
Assistant Regional Administrator

Date: October 18, 2019

LIST OF ACRONYMS

AMM	avoidance and minimization measure
ACID	Anderson-Cottonwood Irrigation District Diversion Dam
BA	biological assessment
BMP	best management practice
°C	degrees Celsius
CCV	California Central Valley
CDEC	California Data Exchange Center
CDFW/CDFG	California Department of Fish and Wildlife
cfs	cubic feet per second
CRs	Conservation Recommendations
CVP	Central Valley Project
dB	decibels
Delta	Sacramento-San Joaquin River Delta
DOC	dissolved organic carbon
DPS	distinct population segment
DQS	Data Quality Act
EFH	essential fish habitat
EPA	United Stated Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionary significant unit
°F	degrees Fahrenheit
FHWG	Fisheries Hydroacoustic Working Group
FWCA	Fish and Wildlife Coordination Act
HAPCs	Habitat Areas of Particular Concern
ITS	incidental take statement
LID	low impact development
mg/L	milligram per liter
MS4	Phase II MS4 General Permit
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	Mossdale Bridge station
NPDES	National Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity units
OHWM	ordinary high water mark
Opinion	biological opinion
PAHs	polyaromatic hydrocarbons
PBFs	physical or biological features
RBDD	Red Bluff Diversion Dam
RMS	root-mean-square
RPMs	reasonable and prudent measures
sDPS	southern distinct population segment
SFS	Stockton Fire Station precipitation station
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program

LIST OF ACRONYMS CONTINUED

SOC	Stockton Airport precipitation station
SRA	shaded riverine aquatic
SWE	snow water equivalent
SWRCB	State Water Resources Control Board
THMFP	total trihalomethane formation potential
TMDL	Total Maximum Daily Load
TOC	total organic carbon
UC Davis	University of California at Davis
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VSP	viable salmonid population
WOUS	Waters of the United States
YOY	young-of-the-year
μg/L	microgram per liter

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1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the NMFS California Central Valley Office in Sacramento, California.

1.2 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). Under the MSA, a Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The U.S. Army Corps of Engineers (Corps) is the lead Federal agency for this project. The Central Valley Flood Protection Board and the San Joaquin Area Flood Control Agency (SJAFCA) are the non-Federal project sponsors partnering with the Corps on Lower San Joaquin River Feasibility Study (LSJRFS). The SJAFCA is requesting authorization to complete the Smith Canal Gate portion of the LSJRFS located in the San Joaquin River, City of Stockton, San Joaquin County, California (Figure 1). A biological opinion was completed in 2016 for the overall LSJRFS, however, new information has been updated regarding the construction of the Smith Canal Gate portion of the project. The 2016 biological opinion (WCR-2015-3809) concluded that the LSJRFS is not likely to jeopardize the continued existence of federally listed species. Below are the proposed project activities for Smith Canal Gate.

The proposed action would implement flood risk-reduction measures in the vicinity of the Smith Canal and the San Joaquin River in and adjacent to the City of Stockton. The proposed action would consist primarily of a fixed wall, filled with granular material, that would extend approximately 800 feet from the north tip of Dad's Point to the right bank of the San Joaquin River at the Stockton Golf and Country Club and would feature a 50-foot-wide gate that would be closed during high flow events forecast to approach or exceed design operating water surface elevations (8.0 feet). During high flow and high tide events, the gate structure would isolate

Smith Canal from the San Joaquin River and allow existing levees to function as a secondary flood risk-reduction measure. The gate would be closed only as needed for flood control to prevent high tide flows from entering Smith Canal, remaining open to allow for recreation, navigation, and tidal movement in and out of Smith Canal. To aid in navigation, U.S. Coast Guard-approved lighting will be installed along the fixed wall structure and at the gate opening.

The opening portion of the gate structure would consist of a miter (double-door gate structure), opening outwards towards the San Joaquin River. When open, the gate doors would recess into the gate structure, providing a 50-foot-wide opening. The structure would be opened and closed by electric motors located above water on top of each gate hinge. The gate panels would be attached to a concrete foundation using stainless steel anchor bolts. The gate panels would be gasket-sealed at their connection to the fixed wall structure and at the point where two panels come together.

The gate structure would be designed so it could be operated locally with programmable preset operating controls. Gate controls would be installed in a weatherproof enclosure on Dad’s Point, adjacent to the fixed wall tie-in. A second set of controls may be located at the end of the sheet pile wall near the shore if safe gate operation is deemed possible from this location. A portable generator can be brought to the western end of Dad’s Point to connect into the power distribution equipment in the event of a power outage.

Improvements to Dad’s Point including the construction of continuous single sheet pile floodwall, placement of fill material, and new recreation amenities would also be completed. Approximately 1,660 linear feet of continuous single sheet pile floodwall would be constructed along Dad’s Point. Most of the sheet pile wall would be entirely underground, but a concrete cap would be installed on top of the sheet pile wall in areas where it would be exposed. Fill material would be placed in some areas to raise the elevation of Dad’s Point, and the crown would be graded to accommodate a 20-foot-wide all-purpose road. As Dad’s Point is currently part of Louis Park, the site would be restored to its existing use and would have new recreation amenities. These amenities would include installation of fishing and wildlife viewing platforms accessible to people with disabilities; construction of a multi-use interpretive trail suitable for walking, running, and bicycling with kiosks and benches; removal of invasive vegetation and planting of native landscaping; and installation of bat boxes, if suitable.

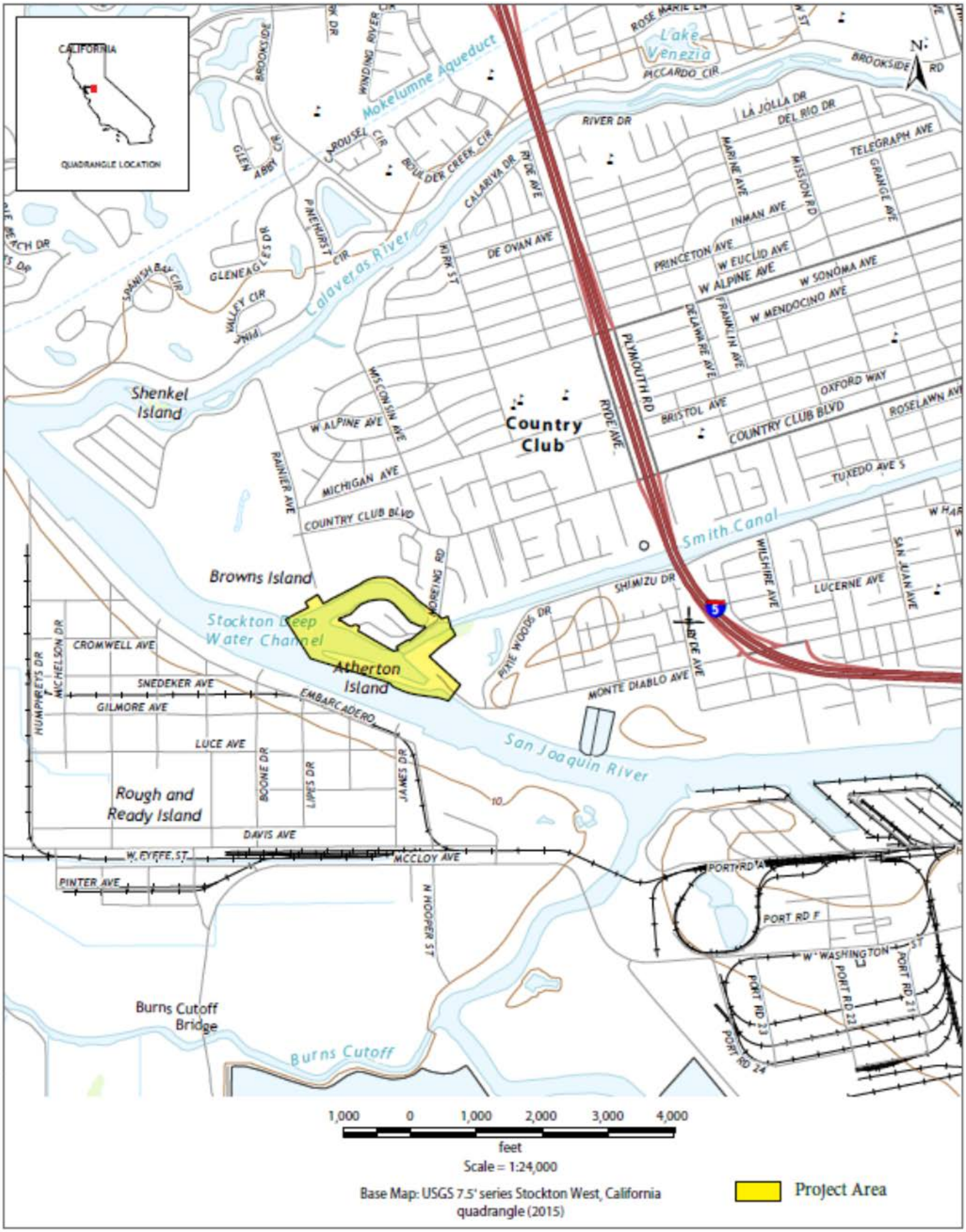


Figure 1. Proposed project area.

Construction Materials

The Louis Park parking area near the boat launch at the base of Dad's Point would be used as a staging area. Construction materials to be used in substantial quantities are steel sheet pilings for the fixed wall, concrete for the gate monolithic structure, riprap boulders for scour protection during flood events, and granular fill material for the fixed wall. Other materials imported to the site could include incidental construction support materials, aggregate base rock, asphalt, concrete, and hydroseed. Materials would be brought to the project site via truck or barge, depending on the location of the staging area, the size, or amount of the material being brought to the site. Barges or boats will be used to deliver materials and equipment via the San Joaquin River and the Stockton Deep Water Ship Channel (DWSC).

Debris from dredging, clearing, and grubbing between the connection of the gate structure and the shoreline would be hauled to one of two permitted disposal sites: the Lovelace Materials Recovery Facility in Manteca, approximately 12.5 miles from the project site, or the North County Recycling Center and Sanitary Landfill in Lodi, approximately 22 miles from the project site. Alternatively, dredged material could be disposed of at an upland site with no connectivity to waters of the United States. Any upland disposal site selected would be closer to the project site than the two facilities described above.

Cofferdam Installation

Construction and installation of the gate structure would begin by installing a metal sheet pile cofferdam, to dewater the work area and allow dry work on the foundation and walls for the gate structure. To form the cofferdam, sheet piles would be driven using a barge-mounted crane equipped with a vibratory hammer. The cofferdam sheet piles would be sized to form the foundation of the gate structure, approximately 71 by 71 feet, and would be the same height as the gate structure (elevation 15.0 feet), extending 10 feet above the mean water level at the entrance to Smith Canal.

The cofferdam would be constructed over a 1-month period during an in-water work window of July 15 to October 15. Construction of the cofferdam would limit access for boat traffic from both Smith Canal and Atherton Cove to an opening north of the cofferdam. The access would be limited until the gate structure would be operational, estimated to be 11 months after construction of the cofferdam.

Dewatering Procedures

Dewatering of the cofferdam area would begin once cofferdam installation was complete and would continue during the entire installation of the gate structure to ensure a dry work substrate. Initial dewatering would take place prior to placement of the foundation. Procedures would be put into place to manage the silt that would likely be removed during the initial dewatering activities. The silt would be allowed to settle within the cofferdam to limit silt discharged during dewatering. The cofferdam is assumed to have a low continuous inflow, resulting in a work area that is not water tight, so a sump pump and generator would be used to remove excess water periodically if it reaches a predetermined level. Should continuous dewatering be needed, bag filters would be used to contain and dispose of silt.

Dredging

Prior to construction of the gate structure and fixed wall, dredging of up to 8,650 cubic yards of the channel bottom may be needed along the length of the fixed wall alignment in order to provide a level surface, as well as dredging in an additional area to allow barge access for pile driving during periods when water surface elevations may be low. Dredging will occur prior to the construction of a cofferdam. Material would be dredged using a combination of a long arm excavator, a dragline excavator, and a clamshell excavator, and silt curtains will be used along the limits of dredging. A turbidity curtain will be used around the dredging area to minimize turbidity.

Gate Structure Construction and Installation

Construction and installation of the gate structure would start once the cofferdam is sufficiently dewatered. Construction of the gate structure would take approximately 6 months. Sixty-four concrete-filled steel pipe piles, approximately 36 inches in diameter, would be driven along the inside edge of the cofferdam to provide support for the concrete floor and walls. The steel pipe piles would be installed by using a barge-mounted crane equipped with a pile driving impact hammer.

Pile driving is likely to cause a small amount of heaving of mud as it is displaced by the piles, which would be removed to get the bottom surface to the correct elevation. The mud removal would be done with either a clamshell excavator or a long-arm track hoe and would be contained within the cofferdam walls.

Following installation of the steel pipe piles, a reinforced concrete floor and the gate structure walls would be formed and poured. Two sides of the cofferdam would be used as forms. The concrete floor would be 69 feet wide, 69 feet long, and 6 feet thick, while the concrete walls would be 71.25 feet long, 22 feet high, and 6 feet thick. The metal gate would be attached to the concrete floor and walls by a barge-mounted crane. The cofferdam sheet pile along the inlet and outlet sides of the gate would be cut down to the level of the gate structure floor by a diver using a torch. The remaining portion of the sheet pile would be kept in place to prevent seepage under the gate structure. Rock protection would be placed at the transitions from the gate structure to the fixed wall to provide scour protection.

The gate would be tested and put into service after construction of the gate structure controls and southern side of the fixed wall is completed. Construction of the northern side of the fixed wall would not take place until after the gate structure has been tested to confirm operability.

Fixed Wall Construction

Following installation of the gate structure cofferdam, work would begin on the fixed wall portion of the proposed action. The fixed wall would extend approximately 800 feet from the north tip of Dad’s Point Levee to the east bank of the San Joaquin River, at the Stockton Golf and Country Club. The fixed wall consists of two cellular web steel sheet pile walls driven into the riverbed by a vibratory hammer. The walls would be constructed to be between approximately 29 feet apart at the connection between cells and 34 feet apart at the widest part of each cell, and would have a top elevation of 15.0 feet, extending 10 feet above the mean water level at the entrance to Smith Canal. The silt in the water between the sheet walls would be allowed to settle before being dewatered.

The north end of the fixed wall would be integrated into the existing FEMA-accredited levee near the Stockton Golf and Country Club. This integration would be designed so that it would not affect the integrity of the existing levee system. Sheet pile wing walls would be driven along the levee perpendicular to the north end of the fixed wall, and the wing walls would be tied into the end of the fixed walls using interlocking sheet piles. Interlocking sheet piles would also be used at the Dad’s Point tie-in, connecting the southern-most cell of the fixed wall to two parallel sheet pile walls driven into the end of Dad’s Point.

Granular material would be installed between the walls using a front-end loader. The granular material would consist of a sand and gravel mixture. Steel cable cross-ties would subsequently be manually installed as the granular material is raised to an elevation within 3 feet of the top of the sheet piles. Upon completion of construction, a locked security gate would be installed at the south end of the fixed wall on Dad’s Point and at the north end of the fixed wall at the Stockton Golf and Country Club. The gate would be 8 feet high and prevent public access to the fixed wall and gate structure. Access to the gate structure through the security gate would be limited to SJAFCA and authorized maintenance representatives.

Once construction of the fixed wall is complete, thirty-five 36-inch steel pipe pile dolphins would be installed on the San Joaquin River side of the wall to protect it from boats colliding into the wall, and two fender piles would be installed on both the San Joaquin River and Smith Canal sides of the gate structure. The pipe piles would be driven using a barge-mounted impact hammer. The dolphin piles would be spaced every 16 feet on each side of the gate structure and would be placed approximately 55 feet away from the centerline of the fixed wall. The fender piles would have a floating fender that would move up and down the pile with the tide, and all four fender piles would have a solar-powered light-emitting diode navigation light mounted on top.

Planter boxes would also be installed along the top edge of the Atherton Cove and Smith Canal side of the fixed wall. The planter boxes would be designed to allow vegetation to hang down over the top half of the wall, but would not extend below the water surface. Construction of the fixed wall would be staggered over 2 years in order to comply with the allowable in-water work period from mid-July to mid-October each year. The southern and northern portions of the fixed wall would be installed during the first and second years of construction, respectively. Construction of the northern side of the fixed wall would not take place until after the gate structure has been tested to confirm operability.

Similar to the construction of the gate structure, work to construct the fixed wall would be done using barge-mounted equipment. The granular material would be delivered to the construction site by a truck or barge using a crane equipped with a clamshell bucket.

Riprap Placement

Once the fixed wall is constructed, approximately 3,400 tons of riprap (approximately 200 linear feet) would be placed along the banks at the Stockton Golf and Country Club (approximately 100 linear feet on each side of the fixed wall). Additionally, 230 linear feet around the tip of Dad’s point. Riprap to be placed would have a maximum diameter of 18 inches, and would be of a gradation that minimizes large voids. The wall tie-ins are designed to be stable, but the riprap would be needed for scour protection during flood events. At the tie-in with the Stockton Golf and Country Club, the riprap would extend along the bank from both the Smith Canal and San Joaquin River sides of the wall. The riprap would be placed using either an excavator or a clamshell bucket.

Floodwall and Fill Placement

Construction of the fixed wall and its use as a flood structure would contribute to a 200-year level of flood protection and meet the 200-year level of protection elevation (15.0 feet). The downstream banks adjacent to the Stockton Golf and Country Club meet this elevation requirement; however, several areas along Dad’s Point do not, including most of its eastern half. To address the elevation deficiency, in addition to seismic stability and seepage concerns, a single sheet pile floodwall would be built, and fill would be placed in additional areas to bring the entirety of Dad’s Point up to a minimum of 15.0 feet in elevation.

To accommodate the new single sheet pile floodwall and fill placement, the existing landscaping and concrete pathway along the middle of Dad’s Point would be removed; however, most of the existing vegetation along the edges of Dad’s Point would be preserved in place. A 1-foot-wide trench would then be excavated using a backhoe between Stations 22+50 and 30+13. Sheet piles would then be installed using a vibratory hammer, and a 1-foot-wide concrete cap would be constructed on top of the single sheet pile wall. The single sheet pile floodwall would be designed in accordance with the USACE Engineering and Construction Bulletin Number 2014-18 (Design and Evaluation of I-Walls Including Sheet Pile Walls) and USACE Engineering Circular Number 1110-2-6066 (Design of I- Walls). Dad’s Point would also be regraded following construction of the floodwall to cover both sides of the floodwall wherever possible, which may require placement of fill material to form a 20-foot-wide levee crown. After grading, an 8-foot-wide all-purpose road would be constructed along the crown to provide access to the southern end of the fixed wall and gate structure. A 12-foot-wide section of concrete pavers would run parallel to the all-purpose road.

In addition, an abandoned 30-inch steel pipe runs through Dad’s Point. The pipe would be removed where feasible and any pipe remnants would be capped at both ends and filled with a cement mix.

Recreation Improvements

Improvements on Dad's Point would be made to increase the recreation opportunities and overall experience for visitors. Recreation facilities developed on Dad's Point would be selected based on current uses of the space including fishing, wildlife viewing, walking, biking, and running. As part of recreation facility implementation, other improvements would be made, such as invasive species removal, revegetation of banks with native riparian species, and replacement of landscaping removed during construction.

Fishing and wildlife viewing from Dad's Point are popular recreation activities. Two fishing and wildlife viewing platforms would be constructed on the river side of the peninsula, spaced approximately 750 feet apart, to provide optimum spaces for engaging in these opportunities. The platforms would be constructed by driving 24-inch steel pipe piles with an impact hammer into the bank that would extend out from the peninsula to support the ramp and platform. The platforms would be 36 feet wide and 12 feet deep, with a ramp for access. The platforms would be Americans with Disabilities Act accessible and have railings for safety and benches for sitting. The platforms would help organize and direct use of the shoreline for recreation activities, and signage placed along the remainder of the shoreline would prohibit its use, where necessary, to help prevent erosion and keep wildlife habitat undisturbed. Construction of the platforms would involve the placement of steel piles within the mean high water mark of the San Joaquin River. In consultation with a qualified biologist, up to five bat boxes would be installed along Dad's Point, if suitable locations are found.

Because invasive plants displace native plants and wildlife, increase wildfire and flood danger, consume valuable water, and degrade recreational opportunities, invasive plants would be removed along the levee and replaced with native vegetation. Removal of invasive trees, shrubs, and herbaceous vegetation from the banks of Dad's Point would remove the source of seeds and additional invasive plants. Areas where invasive plants are removed would be revegetated with native riparian plants. Planting these areas with native riparian plants would increase habitat value, decrease wildfire and flood danger, increase recreation opportunities, and reduce maintenance costs. Herbicides will be used to eradicate non-natives in upland areas (such as glyphosate, 2,4-D, Imazamox, or Penoxsulam). Invasive trees will be cut and will have a stump painted with an herbicide. For other invasive plants, the operator will use a hand wand sprayer from a backpack or from an ATV-mounted tank.

A multi-use interpretive trail suitable for walking, running, and bicycling would be constructed on Dad's Point after the grade adjustment and floodwall construction are complete. Kiosks with interpretive signs would help educate the public on a variety of topics, including local wildlife and plants, the San Joaquin River watershed, the history of the Port of Stockton, the Sacramento-San Joaquin River Delta (Delta), or information about the proposed low water use demonstration plantings at Dad's Point. The signs would be developed with multiple languages presented to reach the widest audience possible. The replacement trail would be constructed as a Class I multiuse trail facility with a minimum 8-foot-wide concrete surface. A 12-foot-wide section of concrete pavers would run parallel to the all-purpose concrete road. Benches and kiosks would also be provided along the trail.

Construction Timing

Construction of the project would last approximately 2 years. The construction sequence and approximate construction timeframes are shown in Table 1.

There would be two primary periods for construction, depending on the type of work:

1) In-Water Work. All work in water would be conducted during an approximate 12-week period from mid-July to mid-October each year. This timeframe is the only time when work that may disturb aquatic habitat would be completed. During that time, work activities would be conducted 10 hours a day, from 7:00 a.m. to 5:00 p.m., up to 7 days per week.

2) Dry Land Work. Work on dry land, including dewatered portions of Smith Canal, would be conducted year-round, depending on weather. Work hours would be 9 hours per day, from 7:00 a.m. to 4:00 p.m., Monday through Friday.

Table 1. Construction timeline for the proposed project

Activity	Month	Construction Year
Mobilize equipment and staging	April–June	Year 1
Construct gate structure • Construct cofferdam • Construct gate structure and install gates	July–March	Year 1
Construct southern portion of fixed wall • Install sheet pile for fixed sheet pile wall south of the gate structure • Place granular material to construct sheet pile fixed wall on south side of gate structure	August–March	Year 1
Construct gate structure controls	October–March	Year 1
Construct Dad's Point Improvements—Phase 1 • Construct single sheet pile floodwall and fill placement along Dad's Point • Remove noncompliant woody vegetation • Install access road on top of Dad's Point	April–June	Year 2
Construct northern portion of fixed sheet pile wall • Install sheet pile for fixed sheet pile wall north of the gate structure • Place granular material to construct sheet pile fixed wall on north side of gate structure	July–October	Year 2
Install dolphin piles and floating fender piles	July–October	Year 2
Place riprap at fixed wall tie-ins	July–October	Year 2
Construct Dad's Point Improvements—Phase 2 • Construct fishing access/wildlife viewing platforms • Remove invasive plant species and landscape • Install bat boxes • Install multi-use interpretive trail	September–October	Year 2

Summary of the Vibratory and Impact Pile Driving Activities

For all pile driving (sheet and pipe), piles will be driven to the maximum depth possible using a vibratory hammer prior to using an impact hammer. It is anticipated that all sheet piles can be driven using only vibratory methods, but it is possible some impact hammering will be needed to reach required depths depending on geotechnical conditions.

Construction of the Smith Canal Gate and associated dolphins and flood walls will require the use of both vibratory and possibly impact pile driving to install the sheet piles for the permanent cofferdam and pipe pile foundations of the gate structure across the canal, the temporary construction support platforms, and the permanent fishing platforms and retaining walls. Steel pipe piles and sheet piles will be placed into the river channel first via vibratory pile driving, and then via impact pile driving for final setting and then load testing during the proposed in-water work window of July 15 to October 15. Most in-water pile driving will be accomplished with a barge-mounted crane, and once the sheet pile retaining wall of the gates form a cofferdam, the internal area will be dewatered so that foundation piles can be installed “in-the-dry.” When construction is complete, vibratory pile driving will be used to remove all temporary support piles and cofferdam sheet piles and parts of an abandoned steel pipe running through Dad's Point.

The sides of the cofferdam around the gate structure that abut the fixed wall will stay in place. For the sides of the cofferdam on the inlet/outlet sides of the gate, a diver will cut the sheet piles to the level of the gate structure floor and the sheets will be removed using a crane. The contractor will excavate and remove the portion of the pipe that is within Dad's Point after installing a concrete plug on the Smith Canal side. A summary of pile driving activities is summarized in Table 2.

Table 2. Summary of pile driving activities

Structure	Number of Piles	Pile Description	Type of Pile Driving	Environment	Estimated Duration
Floodgate Foundation	64	36-inch diameter steel pipe piles	Impact	Inside cofferdam surrounded by water	10 days
Dolphins	39	36-inch diameter steel pipe piles	Impact	In water	4-5 days
Floodgate Cofferdam	71 feet x 71 feet	PZ-40 sheet piles	Vibratory	In water	1 month
Fixed Cellular Sheet Pile Wall	~1,465 sheets	AS-500-12.7 sheet piles	Vibratory	In water	6 months
Fishing Platforms	24	24-inch diameter steel pipe piles	Impact	In water (16) and on land (8)	3-4 days
Dad's Point Flood Wall	770 sheets	NZ-26/AZ-26	Vibratory	On land	60 days

The pile driving assumptions for the Proposed Action have been revised (from 3200 strikes) to allow for up to 5,000 strikes per day during the limited in-water work window, in order to ensure that in-water work and pile driving activities can be completed within the in-water work windows, which would help minimize temporary impacts on special-status fish species. As set forth below, the associated hydroacoustic impacts resulting from pile driving activities were recalculated using up to 5,000 strikes per day, and the analysis was also updated to reflect that impact driving may be used for installation of the cellular sheet pile wall piles, if needed once they have been vibrated in to the maximum depth possible. The analysis assumes that various combinations of pipe piles and sheet piles could be driven on the same day with the same pile driver, and up to 5,000 strikes per day for any given pile or combination of piles.

Test Pile Driving Program and Monitoring Plan

SJAFCA is proposing to conduct a test pile program during the 2019 in-water work window, which would involve vibratory and impact driving a single 20-inch steel flat web sheet pile and "H" pile in three separate locations along the alignment of the cellular sheet pile wall across the mouth of Atherton Cove. The in-water work window specific for this test pile driving would be through November 1 only. The purpose of the test pile program would be to ascertain site-specific subsurface conditions and responses in order to:

1) Verify that piles could be installed to minimum tip elevation with the hammers selected;

2) Evaluate need for any driving aids to achieve the first objective;

3) Ensure that in-water work is limited to two in-water work windows; and,

4) Evaluate peak and cumulative sound exposure levels (SELs) during pile driving operations with and without bubble curtain.

Driving and removal of each test pile would require the use of up to two barges, and up to 1,000 strikes with an impact hammer on each of the three days. Each test pile would first be vibrated to the maximum depth possible, and then would be driven to its design depth using an impact hammer (if needed). The piles would be monitored for structural stresses during installation. Each pile would be removed once it has reached its design elevation.

The test pile program would also include conducting five cone penetration tests (CPTs) across the cellular sheet pile wall alignment. CPTs would involve pressing a sensor mounted on a 2-inch-wide sectional pole into the channel bottom from a barge-mounted rig, with additional sections being added as the pole is pressed further into the channel bed. No impact or vibratory hammer would be needed and the pole would be removed once the desired depth is reached.

As the test pile program would involve minimal temporary impacts during the period in which special-status fish are least likely to be present, and would involve no permanent impacts. SJAFCA requests that the purchase of compensatory mitigation credits for the larger construction project not be required prior to conducting the test pile program.

Funding and other constraints require that the Project be completed by 2021, and construction will require two years. Therefore, it is critical that the test pile program be completed in 2019. To ensure that this is feasible, SJAFCA requests an extension of the in-water work window to November 1 for 2019 only. Project construction will remain subject to previously imposed limitations requiring in-water work to be completed before October 15 for the 2020 and 2021 seasons.

It is anticipated three in-water workdays are needed for the test pile program in a total work period of 5 day including staging and mobilization.
During the in-water workdays there will be actions taken for environmental and biological oversight which include:

1) Environmental Awareness Training
2) Biological Monitoring/Pre Construction Survey for Western Pond Turtle
3) Hydro Acoustical Monitoring
4) Water Quality/Turbidity Monitoring

The fish and wildlife agencies will be contacted if the estimated sound thresholds (NMFS noise criteria) are reached.

Operation and Maintenance

Once complete, the gate structure and the slide gates would be tested as needed, and testing would be scheduled to avoid times when boat traffic is expected to be heavy. During this testing, the gate would be closed and then reopened.

Once the gate structure is deemed fully operational, the gate will normally remain open to allow for tidal movement, navigation, and recreation. It would be closed only as needed for flood control purposes, testing, inspection, and maintenance. For flood control purposes, the gate would be closed only during high flow and high tide events forecasted to exceed the design operating water surface elevation (8.0 feet); events that typically occur between November and April. The gate would be operated as needed during these times to prevent high tides from entering Smith Canal. If a high tide event were anticipated, the gate would be closed at the lowest tide prior to the forecasted high tide. The gate would remain closed until the water level in the San Joaquin River drops down to the water level in Smith Canal, at which point the gate would open. Currently, an urban area of approximately 3,430 acres drains into Smith Canal via nine storm drain pump stations. In the event that rainfall occurs while the gate is closed and causes the water level in Smith Canal to be higher than the Delta, the pump stations that pump into Smith Canal from the surrounding developed areas would be shut off until the gate is opened.

Table 3 below presents the number of gate closures that would have occurred between 1983 and 2013 based on stage data from the Burns Cutoff Gage Station. The number of closures over this 30-year period would have ranged from 0 to 19 times per year, with no closures occurring in 23 of those years.

Table 3. Number of days with stage greater than 8 feet NAVD88

Year	No. Days with Stage ≥ 8.0 Feet NAVD88	Year	No. Days with Stage ≥ 8.0 Feet NAVD88
1983	19	1998	13
1984	2	1999	0
1985	0	2000	0
1986	4	2001	0
1987	0	2002	0
1988	0	2003	0
1989	0	2004	0
1990	0	2005	0
1991	0	2006	8
1992	0	2007	0
1993	0	2008	0
1994	0	2009	0
1995	0	2010	0
1996	0	2011	1
1997	12	2013	0

Based on the information presented in Table 3, it is assumed that there would be two closures per year on average for flood control purposes. This is a conservative estimate, however, based on historical days that were above 8 feet NAVD88. In general, the gate would not need to be closed at a precise point in the tidal cycle. However, if a significant local rain event was predicted to occur at the same time as flood stage on the San Joaquin River near Stockton, timing of gate closure would need to be more precise to maximize storage space for local runoff behind the fixed wall. To be prepared for such an event, SJAFCA would develop a gate operation plan. The plan would include procedures for predicting when river stage would be high and when local rain events might be significant. For example, each year prior to November 1, SJAFCA would obtain tide prediction tables to determine the timing of peak tides. These high tides would be used to develop an "alert" table to help plan activities during the winter months. In addition, because rainfall and runoff affect water surface elevation, daily stage predictions generated by DWR would be monitored. This information would help determine when the gate would be closed for flood control purposes. The gate operation plan would consider that gate closure should occur earlier (at low tide potentially days before the flood flows are expected to arrive) if new storms were predicted for the region. The operation plan would consider scenarios of combined high stage on the San Joaquin River and significant local stormwater runoff.

Routine inspection and maintenance of the gate structure and associated equipment would be conducted on an annual basis to ensure that flood risk-reduction would be provided by the operation of the gate structure. This inspection and maintenance would be conducted on the gate's abutment seals, motors, hinges, and panels. Maintenance of the fixed wall structure corrosion protection system would take place every 2 years. The fill material in the fixed wall would be inspected annually, and additional fill material would be added as required.

Floating debris that has accumulated behind the fixed wall would be regularly removed. The frequency of debris removal would depend on the rate of accumulation, to be determined by regular visual monitoring of the site and collection of information from adjacent residents. Based on the information gathered, SJAFCA would schedule and implement a regular debris removal program, removing debris from the project site as frequently as needed to comply with the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins' direction that "[w]ater shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses."

Water hyacinth (*Eichhornia crassipes*) also would be regularly removed from the areas on the Atherton Cove and Smith Canal side of the fixed wall through development and implementation of a water hyacinth control program to ensure that the cover of water hyacinth in the project area does not increase beyond existing conditions. The frequency of water hyacinth removal would depend on the rate of vegetation growth and accumulation, to be determined by regular visual monitoring of the site. Based on the information gathered, SJAFCA would schedule and implement a regular removal program, removing hyacinth from the project site during the growing season, which is generally from March to early December. During the growing season, mechanical harvesting would be conducted using an aquatic weed harvester whenever cover of water hyacinth reaches 20 percent in the most affected areas behind the fixed wall. The percent cover would be visually estimated from the shoreline.

Conservation Measures

1) Prior to any construction activities onsite, a review of all required permits and notifications will be performed to ensure requirements for environmental compliance are fully understood, specific limits of activities and work are defined and understood, and all environmental clearances and access, encroachment agreements, and permissions have been obtained from the appropriate agencies and parties.

2) An approved biological monitor will be onsite during all construction activities that occur within the channel (i.e., cofferdam dewatering, pile driving). Biological monitors will be notified in advance of all work activities and locations, and scheduled to be onsite as required during vegetation clearing activities.

3) To clearly demarcate the project boundary and protect sensitive natural communities, SJAFCA or its contractor will install temporary exclusion fencing (i.e., minimum 4-foot tall high-visibility orange construction fencing) around sensitive biological resource areas 1 week prior to the start of construction activities.

4) Before any work occurs in the project site, a qualified biologist will conduct mandatory contractor/worker environmental awareness training to brief construction personnel on the need to avoid impacts on sensitive biological resources and the penalties for not complying with permit requirements.

5) Prior to construction activities, environmentally sensitive areas will be flagged or fenced in order to clearly delineate the extent of the construction. All crews will also have a set of environmental drawings showing the locations of the known environmental areas. The

plans will also define the fencing installation procedure. The project's special provisions package will provide clear language regarding acceptable fencing material and prohibited construction- related activities, vehicle operation, material and equipment storage, and other surface- disturbing activities within sensitive areas.

6) Access routes and work areas will be limited to the minimum amount necessary to achieve the project goals. Unpaved routes and boundaries will be clearly marked prior to initiating construction.

7) All equipment will be maintained such that there will be no leaks of machine fluids such as gasoline, diesel, or oils. Containment pans will be placed under stationary equipment in the event of leaks.

8) Hazardous materials such as fuels and oils will be stored in sealable containers in a designated location that is at least 200 feet from any aquatic habitat.

9) The number of access routes, size of staging areas, and the total area of the activity will be limited to the minimum necessary to achieve the project goal. Project limits will be established and defined with physical markers to define access routes and maintenance areas to the minimum area necessary to complete the project; this includes locating access routes and maintenance areas outside of any drainages or creeks.

10) Construction access, staging, storage, and parking areas shall be located on ruderal or developed lands to the extent possible. Vehicle travel adjacent to wetlands and riparian areas shall be limited to existing roads and designated access paths. Sensitive natural communities (e.g., wetlands, water, riparian zones) shall be conspicuously marked in the field to minimize impacts on those communities, and work shall be limited to outside the marked areas.

11) Only tightly woven fiber netting or similar material may be used for erosion control. No plastic monofilament matting will be used for erosion control, as this material may ensnare wildlife or disperse into the environment, increasing the amount of plastic pollution.

12) SJAFCA or its contractor will inspect and clean all equipment being used for brush clearing to minimize the spread of invasive plant species into upland refugia and tidal marsh habitat.

13) Upon completion of the proposed action, all temporarily disturbed natural areas, including stream banks, will be returned to original contours to the extent feasible. Affected wetlands, stream banks or stream channels will be stabilized prior to the rainy season and/or prior to reestablishing flow. Native wetland vegetation will be reestablished as appropriate.

14) SJAFCA or its contractor will implement one or more of the following actions to avoid and minimize the spread or introduction of terrestrial invasive plant species. In addition, SJAFCA will coordinate with the San Joaquin County Agricultural Commissioner to

ensure that the appropriate Best Management Practices (BMPs) are implemented for the duration of the construction of the proposed action.

a. Educate construction supervisors and managers about the importance of controlling and preventing the spread of invasive plant infestations.
b. Use eradication methods that have been approved by or developed in conjunction with the San Joaquin County Agricultural Commissioner during terrestrial invasive species removal to prevent dispersal of the species and/or destroy viable plant parts or seeds. Methods may include use of herbicides approved for use in and near waterways and seasonal removal (i.e., prior to flower and fruit production).
c. Minimize surface disturbance to the greatest extent feasible to complete the work.
d. Use native, noninvasive species or nonpersistent hybrids in erosion-control plantings to stabilize site conditions and prevent invasive plant species from colonizing.
e. Use erosion-control materials that are weed-free or contain less than 1% weed seed.

15) Vegetation will be cleared only where necessary and will be cut approximately 4 inches above soil level. This will allow plants to regrow after construction. All clearing and grubbing of woody vegetation will be done using hand tools, small mechanical tools, or backhoes and excavators.

16) Prior to use of the proposed staging area adjacent to the San Joaquin River, or any other potential staging area that is not graded or paved, SJAFCA will retain a qualified wetland delineator to assess the staging area for the presence of any potential waters of the United States. This assessment does not need to be a complete delineation according to all USACE requirements, but will be adequate for the purposes of determining the approximate boundaries of any potential wetlands or other waters of the United States so that they can be avoided. If potential wetlands or other waters are found within the staging area, they will be shown on a map, fenced, and avoided during all construction activity, including a suitable buffer to avoid any indirect impacts.

17) All slopes or unpaved upland areas temporarily disturbed by construction activities will be revegetated at least 3 days prior to a forecasted rain event with an erosion control seed mix that consists of grasses and herbaceous species that are native or naturalized to the region. The temporarily disturbed areas will be restored to pre-project topography and hydrology to the greatest extent possible.

18) To prevent introduction and/or transport of aquatic invasive species into or from creeks, sloughs or other wetted channels in the Action Area, any equipment that comes into contact with the channel will be inspected and cleaned before and after contact, according to the most current Inspection Standards and Cleaning and Decontamination Procedures (DiVittorio et al. 2012).

Water Quality Measures

Subject to requirements of Section 402 of the Federal Clean Water Act, and the National Pollutant Discharge Elimination System (NPDES) permitting process, all construction projects that disturb more than one acre of land are required to prepare and implement a stormwater pollution prevention plan (SWPPP). The consulting firm selected to prepare detailed construction plans and will also be required to prepare a SWPPP for the project and include it in project plans and specifications. The construction contractor(s) will then be required to post a copy of the SWPPP at the project site, file a notice of intent to discharge stormwater with the Central Valley Regional Water Quality Control Board (Regional Water Board), and implement all measures required by the SWPPP. SJAFCA will be responsible for monitoring to ensure that the provisions of the SWPPP are effectively enforced. In the event of noncompliance, the Regional Water Board will have the authority to shut down the construction site or fine the responsible party or parties.

The SWPPP will include the following information and stipulations:

- A description of site characteristics, including runoff and drainage characteristics and soil erosion hazard.

- A description of proposed construction procedures and construction-site housekeeping practices, including prohibitions on discharging or washing potentially harmful materials into streets, shoulder areas, inlets, catch basins, gutters, or agricultural fields, associated drainage, or irrigation features.

- A description of measures that will be implemented for erosion and sediment control, including requirements for the following.

    - Conduct major construction activities involving excavation and spoils haulage during the dry season, to the extent possible;
    - Conduct all construction work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to storm drains and surface waters.
    - Grade and stabilize spoils sites to minimize erosion and sediment input to surface waters.
    - Implement erosion control measures as appropriate to prevent sediment from entering surface waters, agricultural water features, and storm drains to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets on exposed slopes.
    - A Spill Prevention and Response Plan (SPRP) that identifies any hazardous materials to be used during construction; describes measures to prevent, control, and minimize the spillage of hazardous substances; describes transport, storage and disposal procedures for these substances; and outlines procedures to be followed in case of a spill of a hazardous material. The SPRP will require that hazardous and potentially hazardous substances stored onsite be kept in securely closed containers located away from drainage courses, agricultural areas, storm

drains, and areas where stormwater is allowed to infiltrate. It will also stipulate procedures, such as the use of spill containment pans, to minimize hazards during onsite fueling and servicing of construction equipment. Finally, the SPRP will require that SJAFCA be notified immediately of any substantial spill or release.

- A stipulation that construction will be monitored by SJAFCA personnel to ensure that contractors are adhering to all provisions relevant to state and Federal stormwater discharge requirements, and that SJAFCA will shut down the construction site in the event of noncompliance.

Application of herbicides would be limited to the dry season to avoid potential runoff into adjacent waterways. Herbicides will not be applied during rain events or when winds exceed 10 miles per hour to prevent transport of the herbicide to off-target areas, such as surface waters. Sprayer nozzles will be calibrated to a spray density that avoids drift during application, or a surfactant will be used with the herbicide. Herbicides will be applied at a height no more than approximately four feet above plant canopy. Contractors will follow all herbicide label and requirements.

Turbidity curtains will be used around the cofferdam, and water from the dewatering process would be pumped over the top of the cofferdam and discharged in the area surrounded by the turbidity curtain to allow any silt or suspended sediments to settle back to the channel bottom.

In-Channel Work

In-channel work, including all channel and bank modifications, will be restricted to the dry season (July 15 to October 15). In-channel work will be restricted to low-flow periods between mid-July and mid-October unless otherwise approved by appropriate agencies. This window can be extended based on river conditions, if approved in writing by NMFS. Work from the banks can occur year-round. Work requiring stream dewatering, stream crossings, or work within the live stream will not begin before July 15. To the extent feasible, all in-channel work will be done by equipment operating from dry areas outside the channel.

Special Status Fish Conservation Measures

To avoid or minimize potential injury and mortality of special-status fish species, SJAFCA proposes to implement the following fish protection measures during cofferdam construction and dewatering.

- Silt fences, fiber rolls, silt curtains, and other appropriate sediment control measures will be used to minimize sediment input to the active channel, consistent with the project.

- Lighting at the gate and along the floodwalls will be directed away from the water surface as much as possible in order to decrease the attraction of juvenile salmonids and predatory fish to the area.

- SJAFCA and/or its contractor will ensure that a qualified fish biologist is on site during cofferdam construction and dewatering to supervise fish rescue activities and document any occurrences of stressed, injured, or dead fish. The biologist will be responsible for

  (1) identifying the appropriate capture or exclusion measures;
  (2) overseeing the monitoring, handling, and release of all captured salmonids; and
  (3) maintaining detailed records of fish rescue activities, including species, numbers, life stages, and size classes of listed species observed, collected, relocated, injured, and killed, and environmental conditions (e.g., water temperature) under which fish rescue activities are conducted.

- Potential capture methods during fish salvage will include seines, dip nets, electrofishing, or other methods that minimize the risk of injury. If electrofishing is used, all techniques will be consistent with NMFS Electrofishing Guidelines (National Marine Fisheries Service 2000).

- SJAFCA will require the contractor to implement the following measures, developed in coordination with project design engineers, to minimize the exposure of listed fish species to potentially harmful underwater sounds.

  - If feasible, the contractor will vibrate all piles to the maximum depth possible before using an impact hammer.
  - The smallest pile driver and minimum force necessary will be used to complete the work.
  - During impact driving, SJAFCA will require the contractor to use a bubble ring or similar device to minimize the extent of the interim peak and cumulative SEL to below the noise thresholds (reference the Caltrans impact pile driving handbook: http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.pdf).
  - Pile driving of gate structure piles will occur inside a dewatered cofferdam.
  - No pile-driving activity will occur at night.
  - A sound attenuation device (pile cap cushion) will be used between the drive hammer strike face and the steel piling to avoid direct steel on steel impacts.
  - Construction activities will avoid submerged and emergent aquatic vegetation to the greatest extent possible.
  - SJAFCA and/or its contractor will develop and implement a hydroacoustic monitoring plan prior to pile driving commencement for resource agency approval. The monitoring plan will be submitted to the resource agencies (CDFW, NMFS, USFWS) for approval at least 60 days before the start of project activities. The plan will include the following requirements:
    - SJAFCA and/or its contractor will monitor underwater noise levels during all impact pile driving activities on land and in water to ensure that that peak and cumulative SELs do not exceed fish injury or mortality thresholds.
    - If the levels are exceeded, pile driving will cease and SJAFCA and/or its contractor will contact NMFS to determine whether work can resume.

- The monitoring plan will describe the methods and equipment that will be used to document the extent of underwater sounds produced by pile driving, including the number, location, distances, and depths of the hydrophones and associated monitoring equipment.

- A reporting schedule that includes provision of daily summaries of the hydroacoustic monitoring results to the resource agencies and more comprehensive reports on a monthly basis during the pile driving season.
- The final report will include the number of piles installed per day, the number of strikes per pile, the interval between strikes, the peak sound pressure level (Lpeak), SEL, RMS per strike, accumulated SEL per day at each monitoring station, and when these levels are exceeded, if ever.

Habitat Mitigation

All riparian trees along the edge of the proposed staging area adjacent to the San Joaquin River would be avoided during construction, and any loss of herbaceous riparian vegetation would be temporary and would be anticipated to reestablish after construction. Native vegetation to be replanted would include native grass species. Because the proposed project will permanently destroy some amount of CCV steelhead and southern Distinct Population Segment (sDPS) green sturgeon critical habitat, a purchase of compensatory mitigation credits is included as part of the proposed action to offset this impact to some degree. SJAFCA will purchase salmonid credits at a 3:1 ratio from a NMFS approved mitigation bank. For the permanent destruction of 0.82 acres of tidal perennial habitat, the applicant will purchase 2.46 credits; and for the permanent destruction of 0.83acres of riparian habitat, the applicant will purchase 2.49 credits.

“Interrelated actions” are those that are part of a larger action and depend on the larger action for their justification. “Interdependent actions” are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interrelated or interdependent actions associated with this project.

1.3 Consultation History

On June 7, 2016, NMFS issued a biological opinion on the overall LSJRFS. NMFS concluded that the project was not likely to jeopardize the continued existence of the federally listed species and designated critical habitats. Smith Canal Gate project is one component of the larger LSJRFS project. However, the LSJRFS consultation did not provide a full detailed project description and design for the Smith Canal Gate portion of the project.

On November 6 and 7, 2018, NMFS and the Corps had discussions over the phone and via email regarding how to move forward with the Smith Canal Gate consultation. NMFS and the Corps had discussions regarding whether reinitiation of consultation would be the best option or to consult as an entirely separate project.

On November 27, **2018,** NMFS and the Corps had a conference call to go over a draft BA of the Smith Canal Gate project.

On April 4, 2019, NMFS received an initiation package for the formal section 7 consultation for the Smith Canal Gate project. Upon review of the biological assessment, NMFS provided the Corps with a list of questions.

On May 9, 2019, upon review of the Corps' response email to the information requested by NMFS, NMFS initiated formal consultation.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This biological opinion includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of to "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a ''destruction or adverse modification'' analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.

- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action on both species and their habitat using an “exposure-response-risk” approach.
- Describe any cumulative effects in the action area.
- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the proposed action poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.
- If necessary, suggest a Reasonable and Prudent Alternative to the proposed action.

2.1.1 Conservation Banking in the Context of the ESA Environmental Baseline

Conservation (or mitigation) banks present a unique situation in terms of how they are used in the context of the *Effects Analysis* (section 2.5) and the *Environmental Baseline* (section 2.4) in ESA Section 7 consultations.

When NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a Section 7 consultation occurred at the time of bank establishment. A traditional interpretation might suggest that the overall ecological benefits of the conservation bank actions belong in the *Environmental Baseline*. Under this interpretation, where proposed actions include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double-counting. Such an interpretation does not reflect the unique circumstances that conservation banks serve. Specifically, conservation banks are established based on the expectation of future credit purchases. Conservation banks would not be created and their beneficial effects would not occur in the absence of this expectation.

For these reasons, it is appropriate to treat the beneficial effects of the bank as accruing in connection with and at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. This means that, in formal consultations on projects within the service area of a conservation bank, the beneficial effects of a conservation bank should be accounted for in the *Environmental Baseline* after a credit transaction has occurred. More specifically, the *Environmental Baseline* section should mention the bank establishment (and any consultation thereon) but, in terms of describing beneficial effects, it should discuss only the benefits attributable to credits already sold. In addition, in consultations that include credit purchases as part of the proposed action, the proportional benefits attributable to those credit purchases should be treated as effects of the action. Conversely, where a proposed action does not include credit purchases, it will not receive any direct offset associated with the bank. This approach preserves the value of the bank for its intended purposes, both for the value of the credits to the bank proponent and the conservation value of the bank to listed species and their critical habitat.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value.

The descriptions of the status of species and conditions of the designated critical habitats in this opinion are a synopsis of the detailed information available on NMFS' West Coast Regional website.

The following federally listed species Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs) and designated critical habitat occur in the action area and may be affected by the proposed action (Table 4):

Table 4. Listing for federally listed species.

Species	**Scientific Name**	**Original Listing Status**	**Current Listing Status**	**Critical Habitat Designated**
California Central Valley (CCV) steelhead DPS	*Oncorhynchus mykiss*	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened; confirmed 5/5/2016 Status review	9/2/2005 70 FR 52488
Central Valley (CV) spring-run Chinook salmon ESU	*Oncorhynchus tshawytscha*	9/16/1999 64 FR 50394 Threatened	6/28/2005 70 FR 37160 Threatened	N/A (Does not occur within the action area for this species)
Southern DPS of North American green sturgeon	*Acipenser medirostris*	4/7/2006 71 FR 17757 Threatened	4/7/2006 71 FR 17757 Threatened; confirmed 8/11/2015 Status review	10/9/2009 74 FR 52300

2.2.1 Species Listing and Critical Habitat Designation History

2.2.1.1 CCV Steelhead

The federally listed DPS of CCV steelhead and its designated critical habitat occur in the action area and may be affected by the proposed action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and viable salmonid population (VSP) parameters can be found in the most recent 5-year status review (NMFS 2016).
Historical CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan, 2001). By the early 1960s, the CCV steelhead run size had declined to about 40,000 adults (McEwan, 2001). Current abundance data for CCV steelhead are limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data are the most reliable because redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

CCV steelhead returns to Coleman National Fish Hatchery increased from 2011 to 2014 (see the most recent 5-year status review (NMFS 2016) for further information). After hitting a low of only 790 fish in 2010, 2013 and 2014 averaged 2,895 fish. Wild adults counted at the hatchery each year represent a small fraction of overall returns. Numbers of wild adults returning ranged from 252 to 610 from 2010 to 2014, but their numbers have remained relatively steady, typically 200 to 300 fish each year.

The returns of CCV steelhead to the Feather River Fish Hatchery experienced a sharp decrease from 2003 to 2010, with only 679, 312, and 86 fish returning in 2008, 2009 and 2010, respectively. In more recent years, however, returns have experienced an increase, with 830, 1,797, and 1,505 fish returning in 2012, 2013, and 2014, respectively. Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2015 that no clear trend is present.

An estimated 100,000 to 300,000 naturally produced juvenile CCV steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good et al. 2005). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the U.S. Fish and Wildlife Service (USFWS) Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley. Updated through 2014, trawl data indicate that the level of natural production of steelhead has remained very low since the 2011 status review, suggesting a decline in natural production based on consistent hatchery releases (NMFS 2016). Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the production of wild steelhead relative to hatchery steelhead (CDFW 2018). The overall catch of CCV steelhead has declined dramatically since the early 2000s, with an overall average of 2,705 in the last 10 years. The percentage of wild (unclipped) fish in salvage has fluctuated, but has leveled off to an average of 36 percent since a high of 93 percent in 1999.

About 80 percent of the historical spawning and rearing habitat once used by CCV steelhead in the Central Valley is now upstream of impassible dams (Lindley et al. 2006). Many historical populations of CCV steelhead are entirely above impassable barriers and may persist as resident or adfluvial rainbow trout, although they are presently not considered part of the DPS. Steelhead are well-distributed throughout the Central Valley below the major rim dams (Good et al. 2005, NMFS, 2016). Most steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the Coleman National Fish Hatchery weir), the American River, Feather River, and Mokelumne River.

The CCV steelhead abundance and population growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley et al., 2006). Recent reductions in population size are supported by genetic analysis (Nielsen et al., 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that, unlike coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers. Two hatchery stocks (Nimbus and Mokelumne River Hatcheries) originated from outside the DPS (primarily from the Eel and Mad rivers) and are not presently considered part of the DPS. However, during the recent NMFS 5-year status review for CCV steelhead, NMFS recommended including the Mokelumne River Hatchery steelhead population in the CCV Steelhead DPS due to the close genetic relationship with FRFH steelhead that are considered part of the native Central Valley stock (NMFS 2016). Steelhead in the Central Valley historically consisted of both summer and winter-run timing. Currently, only winter-run (ocean maturing) steelhead are found in California Central Valley rivers and streams as summer-run have been extirpated (McEwan & Jackson 1996, Moyle 2002).

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin River Basin continue to show an overall very low abundance and fluctuating return rates. Lindley et al. (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley et al. (2007) found that data were insufficient to determine the status of any of the naturally spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

Even though CCV steelhead will experience similar effects of climate change to Chinook salmon in the Central Valley, as they are also blocked from the vast majority of their historical spawning and rearing habitat, the effects may be even greater in some cases, as juvenile CCV steelhead need to rear in the stream for one to two summers prior to emigrating as smolts, leaving them more susceptible to warm water events. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile CCV steelhead, which range from 57 degrees Fahrenheit (°F) to 66°F (14 degrees Celsius (°C) to 19°C). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al., 2001). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in steelhead may be impaired by temperatures above 54°F (12°C), as reported by Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild CCV steelhead populations.

In summary, the status of the CCV steelhead DPS in the 2016 status review appears to have remained unchanged since the 2011 status review. Therefore, we concluded that CCV steelhead should remain listed as threatened, as the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (NMFS 2016). All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish to hatchery fish over the past 25 years (Good et al. 2005, NMFS 2016); the long-term trend remains negative. Hatchery production and returns are dominant. Most wild CCV steelhead populations are very small and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to wild fish.

2.2.1.1.1 Critical habitat and PBFs for CCV steelhead

The critical habitat designation for CCV steelhead lists the PBFs (70 FR 52488; September 2, 2005), which are described in their recovery plan (NMFS 2014). In summary, the PBFs include freshwater spawning sites, freshwater rearing sites, freshwater migration corridors, and estuarine areas. The geographical extent of designated critical habitat includes the following: the Sacramento, Feather, and Yuba rivers and the Deer, Mill, Battle, and Antelope creeks in the Sacramento River Basin; the San Joaquin River, including its tributaries but excluding the mainstem San Joaquin River above the Merced River confluence; and the waterways of the Delta.

Many of the PBFs of CCV steelhead critical habitat are degraded and provide limited high quality habitat. Passage to historical spawning and juvenile rearing habitat has been largely reduced due to construction of dams throughout the Central Valley. Levee construction has also degraded the freshwater rearing and migration habitat and estuarine areas as riparian vegetation has been removed, reducing habitat complexity and food resources, and resulting in many other negative ecological effects. Contaminant loading and poor water quality in central California waterways pose threats to lotic fish, their habitat, and food resources. Additionally, due to reduced access to historical habitats, genetic introgression is occurring because naturally produced fish are interacting with hatchery-produced fish, which has the potential to reduce the long-term fitness and survival of this species.

Although the current conditions of CCV steelhead critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento-San Joaquin River watersheds and the Delta are considered to have high intrinsic value for the conservation of the species as they are critical to ongoing recovery efforts.

2.2.1.2 CV spring-run Chinook salmon

The federally listed ESU of CV spring-run Chinook salmon may occur in the action area and may be affected by the proposed action. Its designated critical habitat does not occur within the action area. According to the most recent status review (NMFS 2016a), this ESU would not be expected to be affected by this proposed action. However, since 2015, the San Joaquin River Restoration Program (SJRRP) has been reintroducing CV spring-run Chinook salmon incrementally back into the San Joaquin River mainstem far upstream of the construction area. These actions are to meet a settlement goal that also fulfills a NMFS's recovery requirement regarding this ESU. According to a final rule under ESA Section 10(j), these reintroduced CV spring-run Chinook salmon are designated as a non-essential experimental population inside of the experimental population area, which is generally in the San Joaquin River from its confluence with the Merced River upstream to Friant Dam (78 FR 79622; December 31, 2013).

However, outside of the experimental population area, CV spring-run Chinook salmon are considered part of the CV spring-run Chinook salmon ESU, which is listed as a threatened species. Since the action area for this proposed action occurs outside of the experimental population area but includes the migration corridor the reintroduced fish must take to reach the ocean or return to the experimental population area, NMFS added analysis of the effects of the proposed action on the CV spring-run Chinook salmon ESU to this biological opinion. The number of CV spring-run Chinook salmon returning to the upper San Joaquin River in the experimental population area is expected to increase over time, as experimental hatchery release numbers, adult spawning returns, and the number of juveniles produced naturally in the restoration area increases. Detailed information regarding the ESU's life history, and viable salmonid population (VSP) parameters pertaining to the natural populations that occur in tributaries of the Sacramento River Basin can be found in the most recent 5-year status review (NMFS 2016a).

Since the independent populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, NMFS can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley et al. (2007) indicated that the CV spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of CV spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the "representation and redundancy rule" for the spatial structure parameter since these three populations are the only demonstrably viable populations from one diversity group (northern Sierra Nevada) out of the three diversity groups that historically supported the ESU, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014), which stated a recovery criteria of nine viable populations. Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other. Drought events are also considered to pose a significant threat to the viability of the CV spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

In the latest status review (NMFS 2016a), the authors found, with a few exceptions, CV spring-run Chinook salmon populations had increased through 2014 returns since the previous status review (2010/2011), which moved the Mill and Deer creek populations from the high extinction risk category to moderate, and Butte Creek remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations continued to show stable or increasing numbers the last five years, putting them at moderate risk of extinction based on abundance. Overall, the Southwest Fisheries Science Center concluded in their viability report (Williams et al. 2016) that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased; however, sharp declines were observed in 2015 and 2016 (CDFW 2017). Therefore, the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (NMFS 2016a).

2.2.1.3 sDPS green sturgeon status

- Listed as threatened (71 FR 17757; April 7, 2006)
- Designated critical habitat (74 FR 52300; October 9, 2009)

The federally listed sDPS of North American green sturgeon and its designated critical habitat occur in the action area and may be affected by the proposed action. Detailed information regarding DPS listing and critical habitat designation history, designated critical habitat, DPS life history, and viable population parameters can be found in the 2015 5-year status review (NMFS 2015).

Green sturgeon are known to range from Baja California to the Bering Sea along the North American continental shelf. During late summer and early fall, subadults and non-spawning adult green sturgeon can frequently be found aggregating in estuaries along the Pacific coast (Moser and Lindley 2007). Using polyploid microsatellite data, Israel et al. (2009) found that green sturgeon within the Central Valley of California belong to the sDPS.

Additionally, acoustic tagging studies have shown that sDPS green sturgeon found spawning within the Sacramento River are exclusively sDPS green sturgeon (Lindley et al. 2011). In waters inland from the Golden Gate Bridge in California, sDPS green sturgeon are known to range through the estuary and the Delta and up the Sacramento, Feather, and Yuba rivers (NMFS 2018). It is unlikely that green sturgeon utilize areas of the San Joaquin River upriver of the Delta with regularity, as spawning events are thought to be limited to the upper Sacramento River and its tributaries. There is no known modern usage of the upper San Joaquin River by green sturgeon for spawning (Jackson et al. 2016).

Recent research indicates that the sDPS is composed of a single, independent population, which principally spawns in the mainstem Sacramento River and breeds opportunistically in the Feather River and possibly the Yuba River. Concentration of adults into a few select spawning locations makes the species highly vulnerable to poaching and catastrophic events. The apparent, but unconfirmed, extirpation of spawning populations from the San Joaquin River narrows the available habitat within their range, offering fewer habitat alternatives. Whether sDPS green sturgeon display diverse phenotypic traits, such as ocean behavior, age at maturity, and fecundity, or if there is sufficient diversity to buffer against long-term extinction risk, is not well understood. It is likely that the diversity of sDPS green sturgeon is low, given recent abundance estimates (NMFS 2015).

Trends in abundance of sDPS green sturgeon have been estimated from two long-term data sources: (1) salvage numbers at the state and Federal pumping facilities (CDFW 2018) and (2) by incidental catch of green sturgeon by the California Department of Fish and Wildlife (CDFW)'s white sturgeon sampling/tagging program (DuBois 2016). Historical estimates from these sources are likely unreliable because the sDPS was likely not taken into account in incidental catch data, and salvage does not capture rangewide abundance in all water year types. A decrease in sDPS green sturgeon abundance has been inferred from the amount of take observed at the south Delta pumping facilities (Skinner Delta Fish Protective Facility and the Tracy Fish Collection Facility). Operations and practices at the facilities have changed over the project lifetime, which may affect salvage data. These data likely indicate a high production year versus a low production year qualitatively, but cannot be used to accurately quantify abundance.

Since 2010, more robust estimates of sDPS green sturgeon have been generated. As part of a doctoral thesis at the University of California at Davis (UC Davis), Ethan Mora has been using acoustic telemetry to locate green sturgeon in the Sacramento River and to derive an adult spawner abundance estimate (Mora et al. 2015). Preliminary results of these surveys estimate an average annual spawning run of 223 fish using dual-frequency identification sonar and 236 fish using telemetry. This estimate does not include the number of spawning adults in the lower Feather or Yuba rivers, where sDPS green sturgeon spawning was recently confirmed (Seesholtz et al. 2014).

The parameters of sDPS green sturgeon population growth rate and carrying capacity in the Sacramento River Basin are poorly understood. Larval count data shows enormous variance among sampling years. In general, sDPS green sturgeon year class strength appears to be highly variable with overall abundance dependent upon a few successful spawning events (NMFS 2010). Other indicators of productivity such as data for cohort replacement ratios and spawner abundance trends are not currently available for sDPS green sturgeon.

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate (NMFS 2010). Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010). The most recent 5-year status review for sDPS green sturgeon found that some threats to the species have recently been eliminated such as take from commercial fisheries and removal of some passage barriers (NMFS 2015). Since many of the threats cited in the original listing still exist, the threatened status of the DPS is still applicable (NMFS 2015).

2.2.1.4 Critical habitat and PBFs for sDPS green sturgeon

The critical habitat designation for sDPS green sturgeon lists the PBFs (74 FR 52300; October 9, 2009), which are described in the sDPS green sturgeon recovery plan (NMFS 2018).

In summary, the PBFs include the following for both freshwater riverine systems and estuarine habitats: food resources, water flow, water quality, migratory corridor, depth, and sediment quality. Additionally, substrate type or size is also a PBF for freshwater riverine systems. In addition, the PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas.

In freshwater, the geographical range of designated critical habitat includes:

- The Sacramento River from the Sacramento I-Street bridge to Keswick Dam, including the Sutter and Yolo bypasses and the lower American River from the confluence with the mainstem Sacramento River upstream to the highway 160 bridge.
- The Feather River from its confluence with the Sacramento River upstream to Fish Barrier Dam.
- The Yuba River from its confluence with the Feather River upstream to Daguerre Point Dam.
- The Delta (as defined by California Water Code section 12220, except for listed excluded areas).

Currently, many of the PBFs of sDPS green sturgeon are degraded and provide limited high quality habitat. Factors that lessen the quality of migratory corridors for juveniles include unscreened or inadequately screened diversions, altered flows in the Delta, and presence of contaminants in sediment. Although the current conditions of green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento and San Joaquin River watersheds, the Delta, including the action area, and nearshore coastal areas are considered to have high intrinsic value for the conservation of the species.

2.2.1.5 Climate change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley, and aquatic habitat is climate change. Lindley et al. (2007) summarized several studies (Hayhoe et al. 2004, Dettinger et al. 2004, Dettinger 2005, VanRheenen et al. 2004, Knowles and Cayan 2002) on how anthropogenic climate change is expected to alter the Central Valley, and based on these studies, described the possible effects to anadromous salmonids. Climate models for the Central Valley are broadly consistent in that temperatures in the future would warm significantly, total precipitation may decline, the variation in precipitation may substantially increase (i.e., more frequent flood flows and critically dry years), and snowfall would decline significantly (Lindley et al. 2007). Climate change is having, and would continue to have, an impact on salmonids throughout the Pacific Northwest and California (Battin et al. 2007).

Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen et al. 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991, Dettinger et al. 2004). Specifically, the Sacramento River Basin annual runoff amount for April to July has been decreasing since about 1950 (Roos

1987, 1991). Increased air temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen et al. 2004). Factors modeled by VanRheenen et al. (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100 percent in shallow snowpack areas). Additionally, an air temperature increase of 3.8°F (2.1°C) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen et al. 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the Central Valley, where snowpack is shallower than in the San Joaquin River watersheds to the south.

Modeling indicates that stream habitat for cold water species declined with climate warming and remaining suitable habitat may only exist at higher elevations (Null et al. 2013). Climate warming is projected to cause average annual stream temperatures to exceed 24°C (75.2°F) slightly earlier in the spring, but notably later into August and September. The percentage of years that stream temperatures exceeded 24°C (for at least 1 week) is projected to increase, so that if air temperatures rise by 6°C, most Sierra Nevada rivers would exceed 24°C for a certain number of weeks every year.

Warming is already affecting CV Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 9°F (5°C), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006). In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 57°F to 66°F (14°C to 19°C). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001). In fact, McCullough et al. (2001) recommended an optimal incubation temperature at or below 52°F to 55°F (11°C to 13°C). Successful smoltification in CCV steelhead may be impaired by temperatures above 54°F (12°C), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations. Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951 to 1980, the most plausible projection for warming over Northern California is 4.5°F (2.5°C) by 2050 and 9°F (5°C) by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming would shorten the period in which the low elevation habitats used by naturally producing Chinook salmon are thermally acceptable. This should particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

Central Valley salmonids are highly vulnerable to drought conditions. The increased in-river water temperature resulting from drought conditions is likely to reduce the availability of suitable holding, spawning, and rearing conditions in Clear Creek and in the Sacramento, Feather, and Yuba rivers. During dry years, the availability of thermally suitable habitats in spring-run Chinook salmon river systems without major storage reservoirs (e.g., Mill, Deer, and Butte creeks) is also likely to be reduced. Multiple dry years in a row could potentially devastate Central Valley salmonids. Prolonged drought due to lower precipitation, shifts in snowmelt runoff, and greater climate extremes could easily render most existing spring-run Chinook salmon habitat unusable, either through temperature increases or lack of adequate flows. The droughts that occurred from 2007 to 2009, and from 2012 to 2015, were likely factors in the recent widespread decline of all Chinook salmon runs (including CV spring-run Chinook salmon) in the Central Valley (Williams et al. 2011, Michel et al. 2015).

The increase in the occurrence of critically dry years also would be expected to reduce abundance, as, in the Central Valley, low flows during juvenile rearing and outmigration are associated with poor survival (Kjelson and Brandes 1989, Baker and Morhardt 2001, Newman and Rice 2002). In addition to habitat effects, climate change may also impact Central Valley salmonids through ecosystem effects. For example, warmer water temperatures would likely increase the metabolism of predators, reducing the survival of juvenile salmonids (Vigg and Burley 1991). In summary, climate change is expected to exacerbate existing stressors and pose new threats to Central Valley salmonids, including CCV steelhead, by reducing the quantity and quality of inland habitat (Lindley et al. 2007).

Since 2005, there has been a period of widespread decline in all Central Valley Chinook salmon stocks. An analysis by Lindley et al. (2009) that examined fall-run Chinook salmon found that unusual oceanic conditions led to poor growth and survival for juvenile salmon entering the ocean from the Central Valley during the spring of 2005 and 2006 and most likely contributed to low returns in 2008 and 2009. This reduced survival was attributed to weak upwelling, warm sea surface temperatures, low prey densities, and poor feeding conditions in the ocean. When poor ocean conditions are combined with drought conditions in the freshwater environment, the productivity of salmonid populations can be significantly reduced. Although it is unclear how these unusual ocean conditions affected CCV steelhead, it is highly likely they were adversely impacted by a combination of poor ocean conditions and drought (NMFS 2011).

Although CCV steelhead would experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile CCV steelhead need to rear in the stream for one to two summers prior to emigrating as smolts.

In summary, observed and predicted climate change effects are generally detrimental to all of the species addressed in this biological opinion. Unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure et al. 2013).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

Since the proposed action includes the purchase of mitigation credits from a conservation bank, the Action Area also includes the areas affected by mitigation banks that have service areas relevant to the project areas. These include the Fremont Landing Conservation Bank, which is a 100-acre site along the Sacramento River (Sacramento River Mile 78 through 80); the Bullock Bend Mitigation Bank, which is a 116.15-acre site along the Sacramento River (Sacramento River Mile 80); Cosumnes Floodplain Mitigation Bank, which is a 472-acre site at the confluence of the Cosumnes and Mokelumne rivers (Mokelumne River Mile 22); and Liberty Island Conservation Bank, which is a 186-acre site located at the south end of the Yolo Bypass on Liberty Island in the Delta.

The project is located in the City of Stockton and unincorporated San Joaquin County, California. The project area includes Atherton Island, Atherton Cove, Louis Park (including Dad's Point), the Stockton Golf and Country Club, and the portions of the San Joaquin River in the immediate vicinity. The area north of Smith Canal, Atherton Island, Atherton Cove and Stockton Golf and Country Club, is located in unincorporated San Joaquin County. Louis Park, including Dad's Point, is in the City of Stockton.

Atherton Island is at the west end of Smith Canal, and Louis Park is southeast of Atherton Island at the mouth of the Canal. Dad's Point, a land bar that is an extension of Louis Park, is southwest of the mouth of Smith Canal and separates the Louis Park boat launch area from the San Joaquin River (Figure 2).

Atherton Cove is a dead-end slough of the river that extends north and east around Atherton Island, and the Stockton Golf and Country Club is along the north bank of the river and southwest shore of Atherton Cove, to the northwest of Smith Canal.

The Action area includes waters of the San Joaquin River that are within 1,000 feet upstream and downstream of proposed in-water construction areas. This area represents the potential area of impacts from the proposed project, in addition to noise effects based on pile-driving noise during similar construction activities (Figure 2).

CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon have the potential to occur in the action area during the proposed action's period of construction and long-term operations. Designated critical habitats occur in the action area for CCV steelhead and the sDPS of North American green sturgeon. CV spring-run Chinook salmon critical habitat does not occur in the action area and will not be discussed further in this biological opinion.

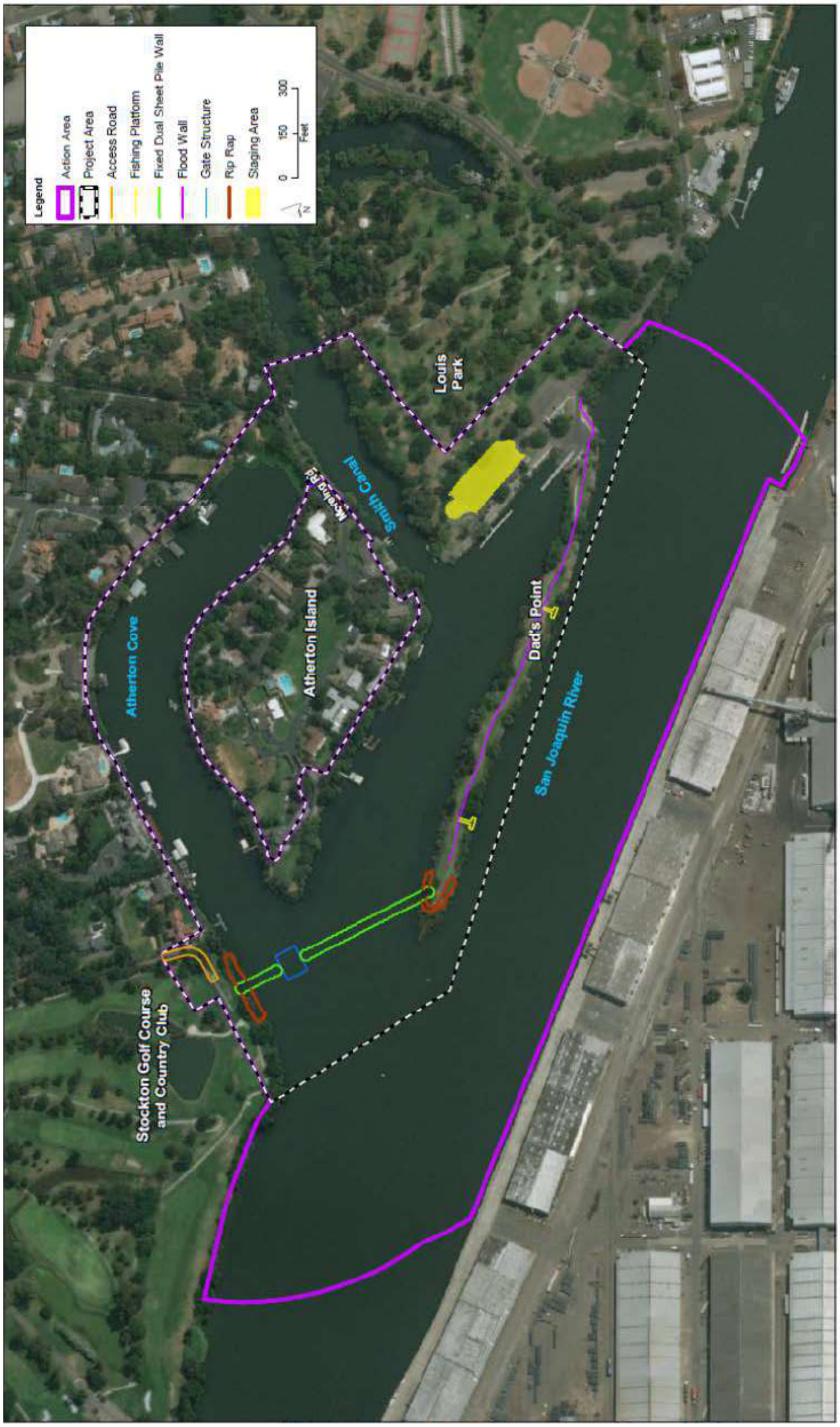


Figure 2. Proposed Action Area (BA 2018)

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.4.1 Occurrence of Listed Species and Critical Habitat in the Action Area

The federally listed anadromous species that use and occupy the action area are migrating adult and juvenile CCV steelhead and CV spring-run Chinook salmon, and juvenile, subadult and adult sDPS green sturgeon. The action area is within designated critical habitat for CCV steelhead and green sturgeon. The San Joaquin River mainstem in the action area is the primary migration corridor for both adult and juvenile CV spring-run Chinook salmon and CCV steelhead life stages spawned in the San Joaquin River Basin to the Delta, which contains important rearing habitat for juveniles. All anadromous fish that utilize the San Joaquin River Basin must also pass by this location at least twice to successfully complete their life histories. Juvenile (including subadult) sDPS green sturgeon may be present throughout the Delta during every month of the year, whereas spawning and post-spawn adults are unlikely to migrate through the action area because their primary migratory route between the ocean and upstream spawning habitats lies predominantly in the Sacramento River and its tributaries.

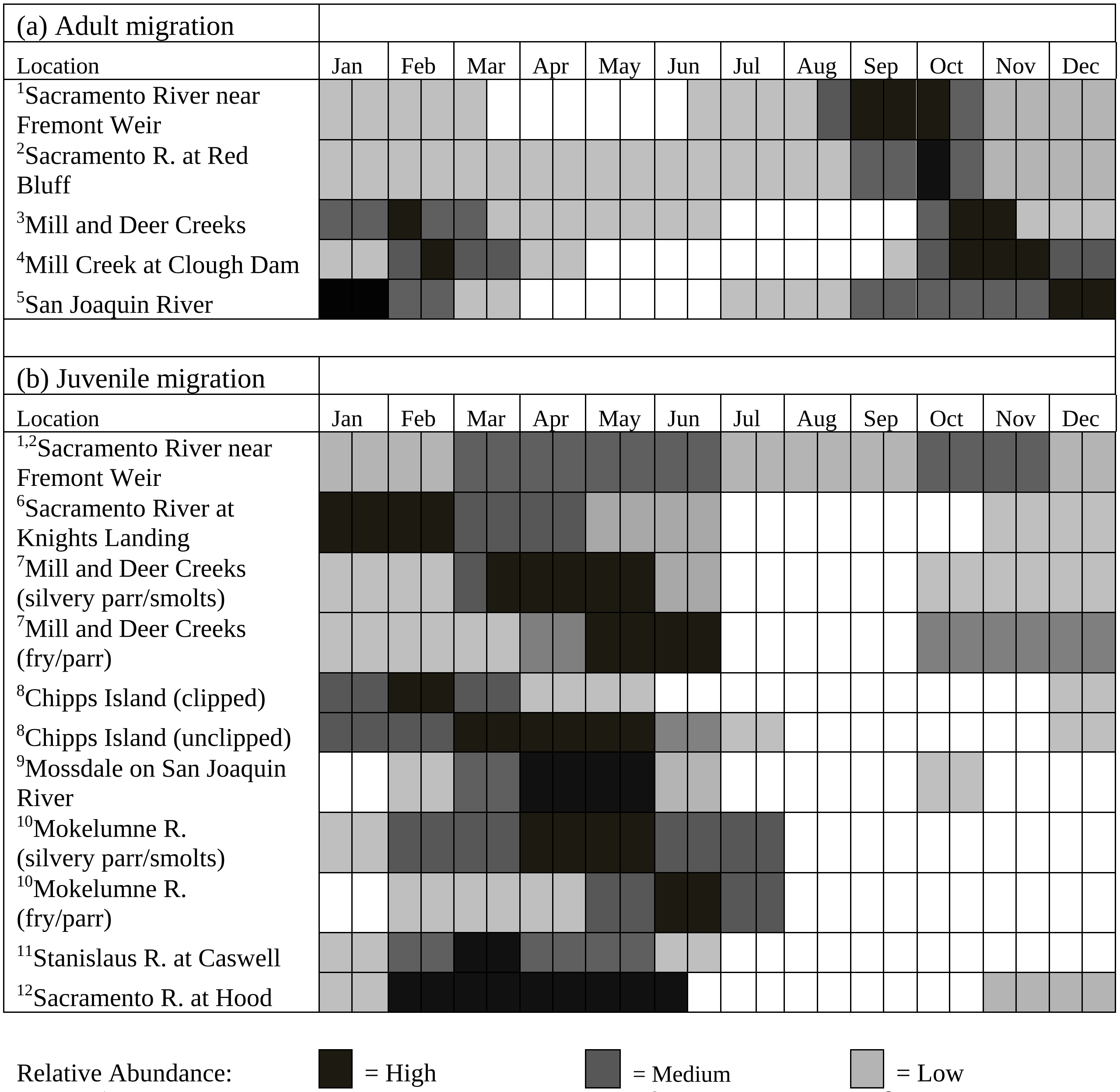
2.4.1.1 CCV steelhead

The life history strategies of steelhead are extremely variable between individuals, and it is important to take into account that CCV steelhead are iteroparous (i.e., can spawn more than once in their lifetime) (Busby et al. 1996), and therefore may be expected to emigrate back down the system after spawning. As such, the determination of the presence or absence of CCV steelhead in the Delta accounted for both upstream and downstream migrating adult steelhead (kelts).

Adult CCV steelhead enter freshwater in August (Moyle, 2002) and peak migration of adults moving upriver occurs in August through September (Figure 3, Hallock et al. 1957). Adult CCV steelhead will hold until flows are high enough in the tributaries to migrate upstream where they will spawn from December to April (Hallock et al. 1961). After spawning, most surviving steelhead kelts migrate back to the ocean and reach the Sacramento River during March and April, and have a high presence in the Delta in May. Migrating adult CCV steelhead through the San Joaquin River are present from July to March, with highest abundance between December and January (Figure 3). Small, remnant populations of CCV steelhead are known to occur in the Stanislaus River and the Tuolumne River and their presence is assumed on the Merced River due to proximity, similar habitats, historical presence, and recent otolith chemistry studies verifying at least one steelhead in the limited samples collected from the river (Zimmerman et al. 2008). Outmigrating juveniles from these tributaries would have to pass through the action area during their emigration to the ocean. Juveniles would emigrate from February through June, with the core of their migration occurring March through May.

The proposed construction period for the proposed actions in the mainstem San Joaquin portion of the action area is from mid-July through mid-October. This will overlap with the adult CCV steelhead migration period in the San Joaquin River Basin (i.e., the months of September and October) but will avoid the peak of spawning migration from November through January.

However, the long-term operations of the project's flood control gates in Smith Canal may overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements. Likewise, the environmental effects of the long-term vegetation policies along the proposed action's levees will overlap with fish presence into the future. Because of the close proximity of the canal to San Joaquin River, a migratory corridor for fish, it is possible that fish can enter the canal through the cove.



Sources: [1](R. J. Hallock, D.H. Fry Jr., and Don A. LaFaunce 1957); [2](D. R. McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson & Merrick, 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by Fishbio) summarized by John Hannon (Reclamation); [12](Schaffter 1980).

Figure 3. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

2.4.1.1.1 CCV steelhead critical habitat

The PBFs for CCV steelhead critical habitat in the action area include freshwater migration corridors and rearing habitat. The freshwater migration utility in the action area is of fair quality, since flows of the lower San Joaquin River are typically of adequate magnitude, quality, and temperatures to support adult and juvenile migration. Most importantly, this section of CCV steelhead critical habitat serves as a migration corridor for all of the adults and juveniles produced and supported by the San Joaquin River and its major tributaries.

During the summer months, migration and rearing habitat is of poor quality due to unsuitable water temperatures and low flows. In addition, rearing habitat is poor as the San Joaquin River is leveed and channelized. The floodplain habitat that would otherwise normally exist has been largely removed near the action area due to the high levees, which limits the value of the area for juvenile rearing. Migratory habitat for adults and juveniles would likely not be impacted due to the project timing because the work window is mostly outside of their migration periods.

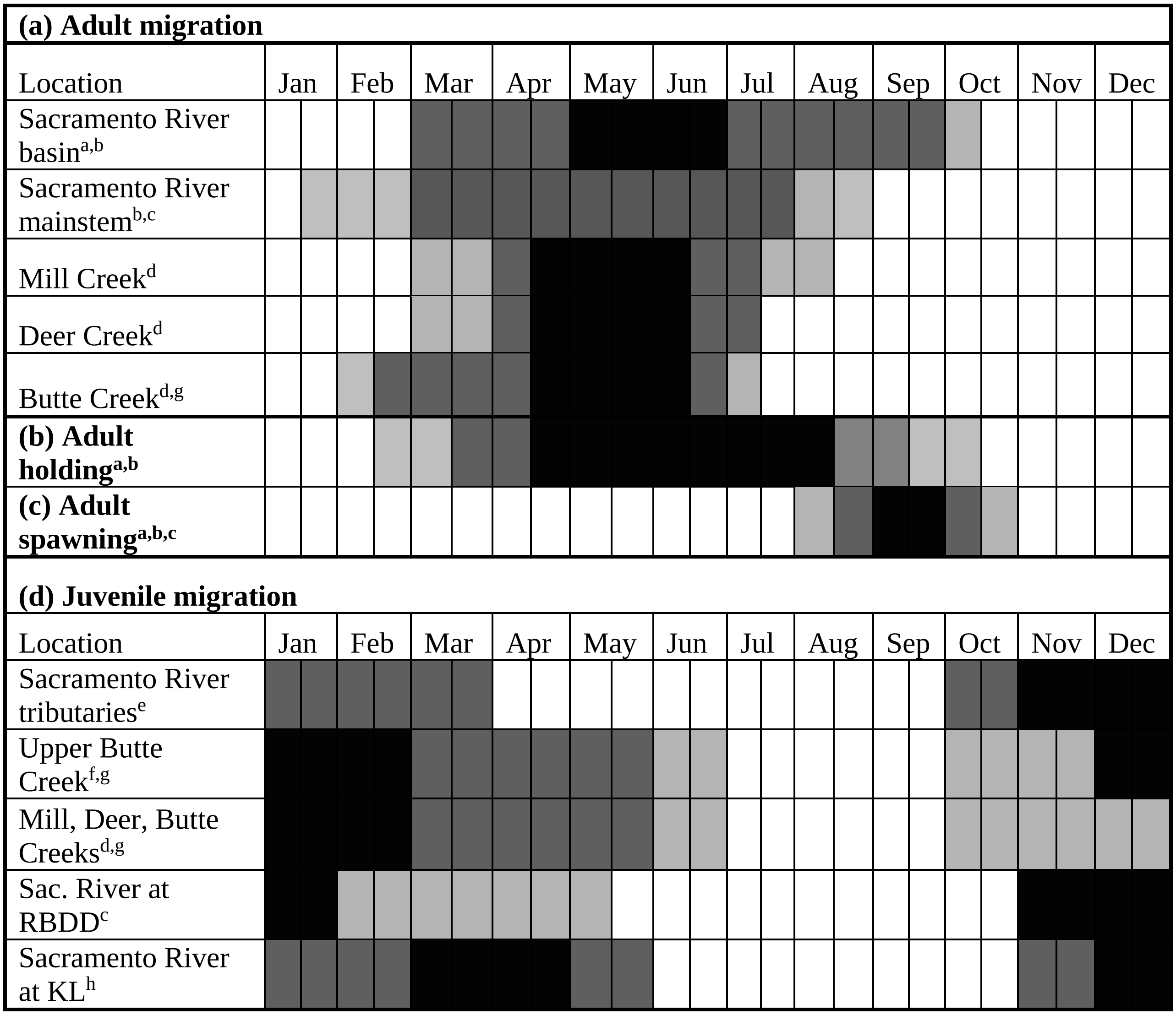
Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the CCV steelhead DPS. A large fraction of the CCV steelhead smolts originating in the San Joaquin River Basin will likely pass downstream through the action area within the San Joaquin River mainstem channel, particularly if there is a fish barrier at the Head of Old River (placed from April to May) to prevent smolt entrance into that route. Likewise, adults migrating upstream to spawn are likely to pass through the action area within the mainstem of the San Joaquin River to reach their upstream spawning areas in the San Joaquin River basin. Therefore, it is of critical importance to the long-term viability of the CCV steelhead to maintain a functional migratory corridor and freshwater rearing habitat through the action area to sustain the Southern Sierra Diversity Group, and provide the necessary spatial diversity to aid in recovery.

2.4.1.2 CV spring-run Chinook salmon

Typical CV spring-run Chinook salmon life history patterns have adults returning to freshwater basins in March (Figure 4). Capitalizing on spring-time runoff, adults travel to holding pools where available in preparation to over-summer. Adults arrive in an immature state and hold over the summer months and develop gonads until ready to spawn in late summer through mid-autumn.

CV spring-run Chinook salmon are considered functionally extirpated from the Southern Sierra Nevada diversity group despite their historical abundance in the San Joaquin River Basin (NMFS 2016). There have been observations of low numbers of spring-time running fish returning to major San Joaquin River tributaries that exhibit some typical spring-run life history characteristics. While the genetic disposition of such fish remains inconclusive, the implementation of reintroduction of the spring-run Chinook salmon into the San Joaquin River has begun and has resulted in over 800 wild-spawned juvenile spring-run Chinook salmon (SJRRP preliminary data presented in weekly reports ending May 7, 2018, Don Portz, Bureau of Reclamation). These juveniles should be imprinted to the upper San Joaquin River mainstem below Friant Dam, and are expected to return as adults when volitional passage is achieved and river conditions are suitable (NMFS 2016).

Based on known spring-run Chinook salmon life history timing and limited information of use of the San Joaquin River Basin, juveniles are expected in the action area November through May as they emigrate through the action area. Returning adults are expected to travel through the action area from March through June. Exact timing of CV spring-run Chinook salmon use of the action area would depend on in-river water being adequate in quality and temperature, and actual life history stage timelines are expected to differ slightly between the Sacramento River and San Joaquin River basins. The proposed construction period for the Project’s actions in the mainstem San Joaquin River portion of the action area is from mid-July through mid-October. There is very little likelihood that either adult or juvenile life history stages of CV spring-run would overlap with this timing. However, the long-term operations of the proposed project’s flood control gates in Smith Canal would overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high astronomical tides or flood events, which will also likely trigger fish movements.



Sources: aYoshiyama et al. (1998); bMoyle (2002); cMyers et al. (1998); dS. T. Lindley et al. (2004); eCDFG (1998); fMcReynolds, Garman, Ward, and Plemons (2007); gP. D. Ward, McReynolds, and Garman (2003); hSnider and Titus (2000)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Relative Abundance: ■ = High ■ = Medium ■ = Low

(Used for reference for the San Joaquin River). Darker shades indicate months of greater relative abundance.)

Figure 4. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River.

2.4.1.3 sDPS green sturgeon

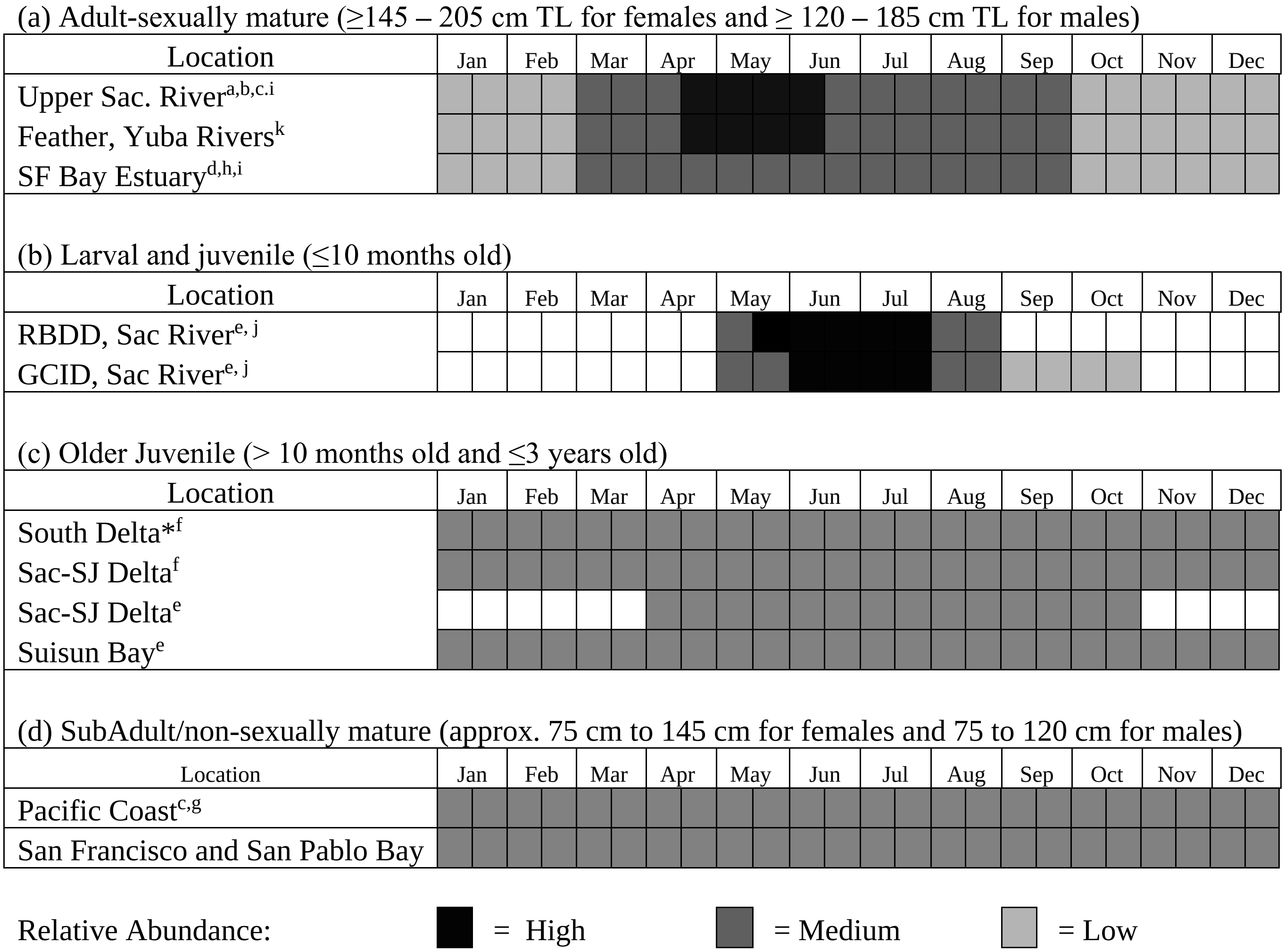
Adult sDPS green sturgeon enter the San Francisco Bay starting in February, have been recorded in San Pablo Bay in March (Heublein et al., 2008), and in the Sacramento River system between late February and late July (Moyle et al., 1995). In general, sDPS green sturgeon enter the San Francisco Bay estuary in winter and continue upstream to their spawning grounds from mid-winter to late-summer. Spawning occurs from April to July in the mainstem Sacramento River (Poytress et al. 2015) and Feather River (Seesholtz et al. 2015). Adults have been recorded out-migrating from the Sacramento River in the fall (November to December) and summer (June to August) (Heublein et al., 2008). It has been suggested that spawning may also occur in the San Joaquin River (Moyle et al. 1995) however, this was based on a 1-year study in the 1960's collecting a large number of young green sturgeon during the summer at a shallow shoal area in the lower San Joaquin River (Radtke 1966). Data on sDPS green sturgeon distribution is extremely limited and out-migration appears to be variable occurring at different times of year. Seven years of CDFW catch data for adult sDPS green sturgeon show that they are present in the Delta during all months of the year. Adult and juvenile sDPS green sturgeon are therefore assumed to be present in the Delta year-round (Figure 5).

Prior to October 2017, all accounts of sDPS green sturgeon sightings in the San Joaquin River Basin were anecdotal at best or misidentified white sturgeon (Gruber et al. 2012, Jackson et al. 2016). During late October in 2017, an adult sDPS green sturgeon was sighted in the Stanislaus River near Knights Ferry by a fish biologist and its identity was genetically confirmed by genetic analysis of green sturgeon environmental DNA in the surrounding water (Breitler, 2017). This is the first confirmed sighting of a green sturgeon in a San Joaquin River tributary, and indicates that adults are able to pass upstream of the proposed action area given river flows of suitable quality and amount. Since only one adult has been confirmed in the Stanislaus River and spawning activities in the San Joaquin River Basin have never been recorded, the production of juveniles from the Stanislaus River is not considered likely in the near future, however with the implementation of recovery actions, potential spawning grounds may become available for sDPS green sturgeon.

While the San Joaquin River Basin may not produce juvenile sDPS green sturgeon, juveniles may use both estuarine and freshwater portions of the Delta to rear for 1 to 3 years prior to exiting the system and entering the Pacific Ocean. During this period, they may range and stray up non-natal waterways searching for appropriate food resources, water quality conditions, and shelter. Therefore, foraging juveniles, subadults, and adults may be found in the San Joaquin River mainstem at the location of the proposed action at nearly any time of year, depending on the local water depth, temperature, and quality.

Both adult and juvenile sDPS green sturgeon are expected to occur in the action area, but in low numbers. The Delta serves as an important migratory corridor for adults during their spawning migrations, and as year round rearing habitat for juveniles. Both non-spawning adults and subadults use the Delta and estuary for foraging during the summer. Since there are no physical barriers to sDPS green sturgeon moving into the action area from the waters of the Delta adjacent to the action area during their rearing or foraging behaviors, presence in the action area is seen as feasible and likely.

The proposed construction period for the project actions in the mainstem San Joaquin portion of the action area is from mid-July through mid-October. Since adult, subadult, and juvenile sDPS green sturgeon may be present in the Delta year round, the construction period will overlap with their presence. Likewise, the long-term operations of the proposed project flood control gates in Smith Canal will overlap with adult, subadult, and juvenile presence in the Delta during the winter when river levels are expected to rise in response to high astronomical tides or flood events occur and the gates are operated. Likewise, the environmental effects of the long-term vegetation policies along the proposed project levees will overlap with fish presence into the future.



* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al*. (1992); [c]Adams *et al*. (2002) and NMFS (2005); [d]Kelly *et al*. (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al*. (1995); [h]Heublein (2009); [i]Gleason et al. 2008, [j]Poytress *et al.* (2011, 2012), [k]Alicia Seesholtz, DWR, personal communication.

Figure 5. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

2.4.1.4 sDPS green sturgeon critical habitat

The action area is close to the southernmost extent of sDPS green sturgeon designated critical habitat in freshwater, which ends just north of the confluence of the San Joaquin River and the Stanislaus River. There is little data regarding the exact services this portion of their critical habitat offers sDPS green sturgeon, except that the San Joaquin River is believed to have historically supported sDPS green sturgeon populations and therefore they must have used this area for migration and perhaps also for foraging and rearing to some degree.

The PBFs of sDPS green sturgeon critical habitat included within the action area are: (1) food resources; (2) adequate water flow regime for all life stages; (3) water quality; (4) and adequate water depth for all life stages. The San Joaquin River mainstem in this section has sufficient depth to support even adult passage, though as stated before only one adult has been observed in the Stanislaus River to date. Spawning in the San Joaquin River Basin may not be currently possible for sDPS green sturgeon given the extent of degradation prevalent throughout the San Joaquin River Basin. Therefore, juveniles are not expected to be produced in this system for some time; however, juveniles produced by the Sacramento River Basin could range into this area during their long rearing period in the Delta.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for sDPS green sturgeon. Due to a deficiency of monitoring data directed at this species, an unknown fraction of the sDPS population utilizes the middle and upper San Joaquin River reaches within the Delta, and even less is known about utilization of the San Joaquin River upstream of the Delta. However, designated critical habitat occurs in the action area and includes the San Joaquin River upstream to the limits of the legal Delta (Vernalis) on the San Joaquin River. Preservation of the functionality of the PBFs within this region is important to the long-term viability of the sDPS green sturgeon population by providing suitable habitat for the rearing of juveniles, and the foraging and migratory movements of adults.

2.4.2 Factors Affecting Listed Species and Critical Habitat in the San Joaquin River

The action area encompasses a small portion of the area utilized by ESA-listed species. Many of the factors affecting these species in the action area are considered the same as throughout their range, as discussed in section 2.2 *(Rangewide Status of the Species and Critical Habitat)* and section 2.4 *(Environmental Baseline)* of this biological opinion. Specifically, levee armoring and channelization, alteration of river flows and timing, reduction of riparian corridors and associated shaded riverine aquatic (SRA) vegetation and the introduction of point and non-point contaminants and are incorporated here by reference. Other factors that impact listed species and critical habitat specific to the action area are discussed below.

2.4.2.1 San Joaquin River Basin water resources

The San Joaquin River is the longest river in California, covering 366 miles, but is considered California's second largest river in California according to average total annual flow (the Sacramento River being the largest). The San Joaquin River has an average mean flow of 6 million acre feet per year compared to the Sacramento River's 18 million acre feet (Reclamation, 2016). It drains the central and southern portions of the Central Valley and joins the Sacramento River near the center of California to form the Delta, the largest estuary on the west coast of the United States. The San Joaquin River is primarily fed (receiving two thirds of its water) by the melting snowpack of the Sierra Nevada Mountains.

The primary storage reservoir on the San Joaquin River is the Friant Dam, which was completed in 1944. Friant Dam created Millerton Lake/Reservoir and can hold more than 500 thousand acre feet in water storage. Friant Dam diverts Sierra snowmelt water into two canals, the Friant-Kern Canal and the Madera Canal, both of which primarily support the irrigation needs of agriculture as part of the Central Valley Project (CVP). Except for releases to manage floods and to meet the requirements of riparian water rights holders, the entirety of San Joaquin River's flow is impounded by the Friant Dam and directed into the canals for distribution. See the existing Coordinated Long-term Operation of the CVP and SWP, and their effects on ESA-listed species and their critical habitats that have been analyzed in the 2009 NMFS CVP Operations Biological Opinion (NMFS 2009) for more information on the effects of federal and state water management on listed species under NMFS jurisdiction. From the high degree of water management of the San Joaquin River, in a typical year, all of the San Joaquin River's flows were allocated to water users. Historically, the river ran dry annually for a 40-mile stretch, only connecting to the Delta during flood releases from Millerton. In recent years, mandated river restoration flows have reconnected the San Joaquin River to the Delta (see section 2.4.2.3, *The San Joaquin River Restoration Program*).

2.4.2.2 San Joaquin River diversions

The Patterson Irrigation District (PID) Fish Screen Intake is located near the City of Patterson, in Stanislaus County, California. The project is located upstream of West Stanislaus Irrigation District (WSID) project, on the west bank of the San Joaquin River, between Merced and Tuolumne rivers. The diversion consists of seven pumps, six vertical turbine pumps and one horizontal centrifugal pump, with a combined pumping capacity of 195 cubic-feet-per-seconds (cfs). PID's original pump station facility used an unscreened intake that had the ability to entrain listed anadromous fish as they migrated through the area. The existing pump station facility could not be retrofitted with a fish screen that would comply with NMFS and the California Department of Fish and Wildilfe's (CDFW) fish screen criteria. As a result, PID constructed a new 195 cfs pump station diversion with a screen with reinforced concrete that is 144 feet long supported on 422 steel piles. The fish screen includes ten stainless steel, high profile bars.

Banta Carbona Irrigation District (BCID) Fish Screen and Fish Bypass System is located near the City of Tracy and is downstream from the San Joaquin River and Stanislaus River confluence. The diversion has a 250 cfs capacity. The fish screen facility consists of a V-shaped screen located within the leveed canal close to the river and 18 panel screens installed vertically in a V configuration with 9 panels to a side. Each panel is 6 feet 1-inch tall and 11-feet 6-inches wide. Fish pass the screens and are pumped through a Hidrostal fish pump to the fish return pipeline on the north levee. This pipeline returns fish back to the river downstream from the diversion point. The positive barrier fish screen is fully consistent with the fish screen criteria of the regulatory agencies including NMFS, CDFW, and the USFWS.

2.4.2.3 The San Joaquin River Restoration Program

The SJRRP is the result of a settlement that was reached in 2006 on an 18-year lawsuit between federal agencies, the Natural Resources Defense Council, and the Friant Water Users Authority (SJRRP, 2009). The settlement is based on two goals: 1) Restore and maintain fish populations in "good condition" in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish; and 2) Reduce and avoid adverse water supply impacts to all Friant Division long-term contractors caused by the interim and restoration flows provided for in the settlement.

As previously identified, some critical recovery actions identified in the NMFS recovery plan are achieved through the implementation of the settlement goals. Though this settlement and the SJRRP actions are restricted to the recovery area, the San Joaquin River mainstem from Friant Dam to the Merced River, the achievement of volitional fish passage from the Delta to the base of Friant Dam would increase the use of the San Joaquin River mainstem within the action area of this project by both adult and juvenile salmonid migration.

2.4.2.4. Mitigation banks

There are several conservation or mitigation banks approved by NMFS with service areas that include the action area considered in this opinion. These banks may offer salmonid credits or credits that would benefit salmonid habitat.

Bullock Bend Mitigation Bank: Established in 2016, the Bullock Bend Mitigation Bank is a 116.15-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento River Mile 80) and is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are salmonid floodplain restoration, salmonid floodplain enhancement, and salmonid riparian forest credits available. To date, there have been 12.5 of 119.65 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CV spring-run Chinook salmon, CCV steelhead as analyzed in this opinion, and sDPS green sturgeon.

Cosumnes Floodplain Mitigation Bank: Established in 2008, the Cosumnes Floodplain Mitigation Bank is 472-acre floodplain site at the confluence of the Cosumnes and Mokelumne Rivers (Mokelumne River Mile 22) and is approved by NMFS to provide credits for impacts to CCV steelhead. There are shaded riverine aquatic, floodplain riparian, and floodplain mosaic wetlands credits available. To date, there have been 22.39 of 38.13 floodplain credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is a 100-acre site near the confluence of the Feather River and the Sacramento River, at river mile 78 through 80, on the west bank of the Sacramento River. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Out of 100 acres of potential credits, 28.283 acres have been sold/withdrawn and the ecological value (increased rearing habitat for juvenile salmonids) of these credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

Liberty Island Conservation Bank: Established in 2010, the Liberty Island Conservation Bank is a 186-acre site located at the southern end of the Yolo Bypass on Liberty Island in the Delta. Out of the credits relating to salmonid restoration or preservation, 27.67 acre have been sold/withdrawn. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are riparian shaded aquatic, salmonid preservation, and salmonid restoration credits available, and the ecological value of the sold credits (increased rearing habitat for juvenile salmonids) are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

2.4.3 NMFS Salmon and Steelhead Recovery Plan Action Recommendations

The NMFS Recovery Plan that includes both CCV steelhead and CV spring-run Chinook salmon (NMFS, 2014) identifies recovery goals for the San Joaquin River Basin populations whose range includes the proposed action area. Recovery efforts focus on addressing several key stressors that are vital to both CCV steelhead and CV spring-run Chinook salmon: (1) elevated water temperatures affecting adult migration and holding; (2) low flows and poor fish passage facilities, affecting attraction and migratory cues of migrating adults; and (3) possible catastrophic events (e.g., fire or volcanic activity).

2.4.3.1 CCV Steelhead DPS

The NMFS Recovery Plan (NMFS, 2014) strategy for CCV steelhead lists the San Joaquin River's eastside tributaries (Stanislaus, Tuolumne, and Merced rivers) as Core 2 populations (meaning these watersheds have the potential to support viable populations, due to lower abundance, or amount and quality of habitat) downstream of major dams, and as candidates to reach viable population status if reintroduced upstream of the dams, and lists the San Joaquin River, below Friant Dam, as a candidate to reach viable population status.

2.4.3.2 CV Spring-run Chinook salmon

The NMFS Recovery Plan (NMFS, 2014) indicates that for CV spring-run Chinook salmon, re-establishing two viable populations in the San Joaquin River Basin would be necessary for recovery. The action area is considered to be a priority for re-introduction for CV spring-run Chinook salmon and is a migratory corridor to the upper reaches of the San Joaquin River, below Friant Dam.

2.4.3.3 sDPS green sturgeon

As previously mentioned, the San Joaquin River is not known to currently host sDPS green sturgeon spawning; therefore, the San Joaquin River Basin is not a main focus of their recovery plan. Though the sDPS does utilize the lower San Joaquin River and the discovery of an individual adult in the Stanislaus River in October 2017 highlights that passage for adults is possible during certain river conditions, the recovery plan and efforts are not likely to be modified unless adult spawning or juvenile reproduction occurs (NMFS, 2018).

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the proposed action and are later in time, but still are reasonably certain to occur.

The following is an analysis of the potential direct and indirect effects to listed fish species that may occur as a result of implementing the proposed action on the San Joaquin River.[1] For our analysis, we have used the presence of listed species in the action area to determine the risk each species and life stage may face if exposed to project impacts. The expected effects of the proposed action include impacts due to: (1) water quality, (2) noise exposure, (3) dewatering and fish relocation, (4) habitat loss/modification, (5) and operations and maintenance.

2.5.1 Direct and indirect effects to species: Construction impacts, pile driving, and maintenance

2.5.1.1 Construction Impacts

Water Quality: Sediment and Turbidity

Construction activities could result in turbidity, suspended sediment concentrations, and contaminant concentrations. Construction activities could disturb sediments and soils within and adjacent to waterways. These activities, including construction of the new tidal gate, use of staging areas, installation of sheet piles, wildlife viewing platforms, riprap placement, and placement of excavated material, could disturb sediments and soils within and adjacent to waterways. Any construction-related erosion or disturbance of sediments and soils would increase downstream turbidity and sedimentation in the project area if soils were transported in river flows. During the long-term period of gate operations, the narrow gate opening (~50 feet) will create a higher velocity flow through the structure than currently exists through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

The abundance, distribution, and survival of fish populations have been linked to levels of turbidity and silt deposition. Prolonged exposure to high levels of suspended sediment could create a loss of visual capability in fish in aquatic habitats within the project area, leading to reduced feeding and growth rates. Such exposure could also result in a thickening of the gills, potentially causing the loss of respiratory function; in clogging and abrasion of gills; and in

[1] As stated previously, there are no interrelated or interdependent actions associated with this project.

increased stress levels, which in turn could reduce tolerance to disease and toxicants (Waters 1995). Turbidity also could result in increased water temperature and decreased dissolved oxygen (DO) levels, especially in low-velocity pools, which can cause stressed respiration.

High levels of suspended sediments could also cause redistribution and movement of fish populations in the San Joaquin River, and could diminish the character and quality of the physical habitat important to fish survival. Deposited sediments can reduce water depths in stream pools and can contribute to a reduction in carrying capacity for juvenile and adult fish (Waters 1995). Increased sediment loading downstream from construction areas could degrade food-producing habitat by interfering with photosynthesis of aquatic flora, and could displace aquatic fauna.

Many fish, including salmonids (Chinook and steelhead), are visual feeders and turbid waters reduce the ability of these fish to locate and capture prey. Some fish, particularly juveniles, could become disoriented and leave the areas where their main food sources are located, ultimately reducing growth rates. Prey of fish populations, such as macroinvertebrates, could be adversely affected by declines in habitat quality (water quality and substrate conditions) caused by increased turbidity, decreased Dissolved Oxygen (DO) content, and an increased level of pollutants.

Avoidance of adverse habitat conditions by fish is the most common result of increases in turbidity and sedimentation (Waters 1995). Fish are not expected to occupy areas unsuitable for survival unless they have no other option. Therefore, increased turbidity attributed to construction activities could preclude fish from occupying habitat required for specific life stages. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 nephelometric turbidity units [NTUs]) that are expected to result from this proposed project. Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barret *et al.* 1992).

During installation of the sheet piles, wildlife viewing piles, riprap placement, and dredging, there would be an increase in sediment and turbidity. The Smith Canal structure is anticipated to take two years for completion, with the majority of the work occurring over the two summer work windows. During these periods, NMFS anticipates that construction related turbidity events will occur as a direct effect of the proposed project's actions.

These in-water work activities that would result in increased sediment and turbidity would occur during mid-July to mid-October. This period coincides with when CCV steelhead are least likely to be present in the action area. Adult CCV steelhead may commence their upstream migration as early as October. However, juveniles would not likely be migrating downstream during this time. There is likely to be little exposure to any CV spring-run adults resulting from the reintroduction efforts based on the expected timing of their life histories. Rearing juveniles and resident or holding CCV steelhead and CV spring-run Chinook salmon are not expected to occur in the project site during the in-water work window due to unsuitable habitat conditions such as warm water temperatures; these species are only likely to be present within the project site during migrations so timing the construction outside of the primary migratory periods will limit the potential for CV spring-run Chinook and CCV steelhead to be present during construction and be impacted by construction activities. NMFS expects that foraging adult sDPS green sturgeon and rearing juvenile sDPS green sturgeon could be present in the Delta. However, diminished water quality (low DO, low flow, and increased water temperatures) in the action area would preclude presence of green sturgeon during the in-water work window.

Installation of the sheet piles and platform pilings is expected to result in short-term, localized increases in turbidity. Therefore, there could be some impacts to the listed species if present during the installation of the cofferdam and associated construction activities. However, because the cofferdam will isolate the work area, continued increases and sediment mobility during in-water work activities is not expected to occur.

Actions that take place early in the work window on the San Joaquin River (July through September) are expected to have minimal effects on listed salmonids since the likelihood of their presence in the action area is considered low. Should in-water work be postponed or started later in the work window (*i.e.*, September or October), then the probability of in-water work overlapping with listed salmonid presence increases and the potential for exposure to elevated turbidity increases. This increases the risk for non-lethal levels of take to exposed fish, although the level of risk is considered to be still quite low.

Water Quality: Contaminants

During construction, the potential exists for spills or leakage of toxic substances that could enter the waterways. Refueling, operation, and storage of construction equipment and materials could result in accidental spills of pollutants (e.g., fuels, lubricants, sealants, and oil). Adverse effects to listed fish may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include, but are not limited to ammonia/ammonium, pesticides and herbicides, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into the waterways from shipping and boating activities and from urban activities and runoff. These contaminants may adversely affect fish reproductive success and survival rates. Fish could also be exposed to legacy contaminants during sediment disturbing activities such as dredging.

High concentrations of contaminants can cause direct and indirect effects to fish. The severity of these effects depends on the contaminant, the concentration, duration of exposure, and sensitivity of the affected life stage. Sublethal effects include increased susceptibility to disease that reduces the overall health and survival of the exposed fish. An indirect effect of contamination is reduced prey availability. Invertebrate prey species survival can be reduced therefore making food less available for fish. Also, fish consuming infected prey can absorb toxins directly. However, only a small number of salmonids would be expected to be exposed to such effects because of the timing of in-water work.

Green sturgeon may be more susceptible to aquatic contaminants since they are benthic foragers. Studies on white sturgeon found that bioaccumulation of pesticides and other contaminants adversely affect growth and reproductive development (Feist et al. 2005). However, green sturgeon occurrence in the relatively shallow water of the action area during sediment disturbance is likely to be limited because the species tends to occupy deeper water by day.

With the implementation of the water quality conservation measures (as described in the project description) and in-water work window, the potential effects associated with contaminants are expected to be avoided.

Noise Exposure

2.5.1.2 Vibratory and impact pile driving

Construction of the Smith Canal Gate and associated dolphins and flood walls will require the use of both vibratory and impact pile driving to install the sheet piles for the permanent cofferdam and pipe pile foundations of the gate structure across the canal, the temporary construction support platforms, and the permanent fishing platforms and retaining walls. Table 5 describes a summary of all pile driving activities.

A pile driving test will be conducted the year prior to starting construction in 2019, to gather data on site-specific subsurface conditions to ensure subsequent in-water pile driving work is completed in two seasons, and to evaluate the observed underwater sounds created during the test and the effectiveness of sound attenuation measures. During the test, a 20-inch steel sheet pile and an “H” pile will each be driven into the riverbed from two barges at three locations in the construction area. Each test pile would first be vibrated to the maximum possible depth, and then driven to its design elevation with an impact hammer. No more than 1,000 impact strikes per day would be performed during the test period and the test piles will be removed via vibratory pile driving before moving on to the next sampling location. In addition, five CPTs will be conducted across the cellular sheet pile wall alignment, which involves pressing a sensor mounted on a 2-inch wide sectional pole into the channel bottom from a barge-mounted rig but since these CPTs do not involve pile driving, effects of CPTs are not analyzed in this section. While the test pile program is short in duration (three in-water work days), it is believed that the test program will require extension past the fish avoidance in-water work window, up to November 1, to complete all testing in the 2019 construction season. During the test program, environmental awareness training, biological monitoring, hydroacoustic underwater sound monitoring, and turbidity monitoring will be ongoing.

During the construction period, steel pipe piles and sheet piles will be placed into the river channel first via vibratory pile driving to the maximum depth possible or desired, and then via impact pile driving for final setting and then load testing during the proposed in-water work window of July 15th – October 15th. To ensure in-water pile driving work is completed in two construction seasons, it is estimated up to 5,000 impact strikes per day are necessary. Most in-water pile driving will be accomplished with a barge-mounted crane, and once the sheet pile retaining wall of the gates form a cofferdam, the internal area will be dewatered so that foundation piles can be installed “in-the-dry.” Water depths in the pile driving locations are assumed to be variable but less than 5 meters overall.

Table 5. Summary of all pile-driving associated activities for the Smith Canal Gate and associated structures (Table from Corps Biological Assessment).

Structure	**Number of Piles**	**Pile Description**	**Type of Pile Driving**	**Environment**	**Estimated Duration (days)**
Test Piles	6 (test of each at three locations)	20-inch steel sheet piles and "H" piles	Vibratory & Impact	In water	3 days
Floodgate Foundation	64	36-inch diameter steel pipe piles	Impact	Inside cofferdam surrounded by water	10
Dolphins	39	36-inch diameter steel pipe piles	Impact	In water	4-5
Protective Piles Around Dolphins	18	20-inch diameter steel pipe piles	Impact	In water	3-4
Floodgate Cofferdam	71 feet x 71 feet	PZ-40 sheet piles	Vibratory	In water	1 month
Fixed Cellular Sheet Pile Wall	~1,465 sheets	AS-500-12.7 sheet piles	Vibratory	In water	6 months
Fishing Platforms	24	24-inch diameter steel pipe piles	Impact	In water (16) and on land (8)	3-4
Dad's Point Flood Wall	770 sheets	NZ-26/AZ-26	Vibratory	On land	60

Pile driving near or in water has the potential to kill, injure, and cause delayed death to fish through infection of minute internal injuries, or cause sensory impairments leading to increased susceptibility to predation. The pressure waves generated from driving piles into river bed substrate propagate through the water and can damage a fish's swim bladder and other internal organs by causing sudden rapid oscillations in pressure, which translates to rupturing or hemorrhaging tissue in the bladder when the air in swim bladders expand and contract (Gisiner 1998, Popper, Carlson et al. 2006). Sensory cells and other internal organ tissue may also be damaged by pressure waves generated during pile driving activities as sound reverberates through a fish's viscera (Caltrans 2015). In addition, morphological changes to the form and structure of auditory organs (saccular and lagenar maculae) have been observed after intense noise exposure (Hastings and Popper 2005). Smaller fish with lower mass are more susceptible to the impacts of elevated sound fields than larger fish, so acute injury resulting from acoustic impacts are expected to scale based on the mass of a given fish. Since juveniles and fry have less inertial resistance to a passing sound wave, they are more at risk for non-auditory tissue damage (Popper and Hastings 2009) than larger fish (yearlings and adults) of the same species. Beyond immediate injury, multiple studies have also shown responses in the form of behavioral changes in fish due to human-produced noises (Wardle et al. 2001, Slotte et al. 2004, Popper and Hastings 2009).

Based on recommendations from the Fisheries Hydroacoustic Working Group (FHWG), NMFS uses an interim dual metric criteria to assess onset of injury for fish exposed to pile driving sounds (NMFS 2008, Caltrans 2015, Caltrans 2019). The interim thresholds of underwater sound levels denote the expected instantaneous injury/mortality and cumulative injury, as well as a third threshold criteria for behavioral changes to fish. Impact pile driving is expected to produce underwater pressure waves at all three threshold levels. Vibratory pile driving generally stays below injurious thresholds but often introduces pressure waves that will incite behavioral changes. Even at great distances from the pile driving location, underwater pressure changes/noises from pile driving is likely to cause flight, hiding, feeding interruption, area avoidance, and movement blockage as long as pile driving is ongoing.

For a single strike, the peak exposure level (peak) above which injury is expected to occur is 206 decibels (dB) (reference to 1 micro-pascal [1µpa] squared per second). However, cumulative acoustic effects are expected for any situation in which multiple strikes are being made to an object with a single strike peak dB level above the effective quiet threshold of 150 dB. Therefore, the accumulated SEL level above which injury to fish is expected to occur is 187 dB for fish greater than 2 grams in weight, and 183 dB for fish less than 2 grams. If either the peak SEL or the accumulated SEL threshold is exceeded, then physical injury is expected to occur to fish within the estimated distance thresholds. Underwater sound levels below injurious thresholds are expected to produce behavioral changes. NMFS uses a 150 dB root-mean-square (RMS) threshold for behavioral responses in salmonids and green sturgeon. Though the dB value is the same, the 150 dB RMS threshold for behavioral effects is unrelated to the 150 dB effective quiet threshold.

According to the Caltrans 2012 pile driving compendium of field data (Caltrans 2012), in-water impact pile driving of the 36-inch diameter steel pipe piles for this project could generate unattenuated underwater sound waves of up to 210 dB peak, 190 dB SEL, and 190 dB RMS, as measured at 10 meters from the strikes, in approximately 5 meters of water depth or less (Table 6). These estimates are calculated from field data gathered from pile driving activities at other locations and are considered informative only, not the definite levels that will be generated by impact pile driving in the San Joaquin River/Smith Canal/Atherton Cove during the course of this project. This is because each pile driving situation is unique and variations in the substrate, channel shape, depth, salinity, and water temperature can alter how the underwater pressure waves propagate and the amount of transmission loss that will dampen the underwater sounds as they travel.

Table 6. Expected maximum unattenuated hydroacoustic sounds based on the size of pile and method of placement, empirical data from the 2012 FHWG pile driving compendium Caltrans (Caltrans 2012).

Pile Type	Driver Type	Pile Location	Reference Distance	Peak (dB)	SEL (dB)	RMS (dB)
15-inch diameter steel "H" piles (thin-walled)	Impact	In water, >4 meters depth	10 meters	187	154	164
20-inch diameter steel pipe piles	Impact	In water, >5 meters depth	10 meters	208	176	187
20-inch diameter steel pipe piles	Impact	In water, >5 meters depth	20 meters	201	173	184
20-inch diameter steel pipe piles	Impact	On land	10 meters	198	171	183
20-inch diameter steel pipe piles	Impact	On land	20 meters	188	NA	172
24-inch diameter steel pipe piles	Impact	In water, ~ 5 meters depth	10 meters	203	177	190
30-inch diameter steel pipe piles	Impact	In water, +/- 3 meters depth	10 meters	210	177	190
36-inch diameter steel pipe piles	Impact	In water, <5 meters depth	10 meters	208	180	190
36-inch diameter steel pipe piles	Impact	On land	10 meters	201	174	186
36-inch diameter steel pipe piles	Impact	On land	20 meters	198	171	183
36-inch diameter steel pipe pile	Vibratory	In water, ~ 5 meters	10 meters	180-185	170-175	170
24-inch AZ steel sheet pile	Vibratory	In water, ~15 meters	10 meters	175-182	160-165	160-165
24-inch AZ steel sheet pile	Impact	In water, 12-14 meters	10 meters	203-205	175-179	187-189

Test Pile Driving Program Effects

Worst-case scenario for the test pile driving program (20-inch or greater sheet pile, impact pile in water driving, 1,000 strikes per day without attenuation) is the production of underwater sound of 203-205 dB peak/175-179 dB SEL/187-189 dB RMS. According to the NMFS Pile Driving Calculator (NMFS 2008), this scenario would produce instantaneous mortality out to a distance threshold of 9 meters from the driven pile (Table 6). For a fish above 2 grams (as those that would be expected within the action area in the work period), the distance at which injury is expected to occur due to cumulative SEL exposure greater than 187 dB is out to 293 meters from the driven pile (Table 7). The distance within which behavior changes are expected is 3,981 meters from the driven pile (Table 7), where the RMS sound will be above 150 dB RMS. SELs below 150 dB are assumed to not accumulate to an extent that results in injury to fish, or be significantly different from ambient conditions, (i.e., effective quiet). Underwater cumulative SEL exposure above 187 dB is expected out to 293 meters from the sampling locations, which is poignant considering the San Joaquin River in this location is approximately 250 meters in width, meaning fish could not pass the construction site without potentially receiving injury from these activities.

Pressure levels in excess of 150 dB_{RMS} are expected to cause temporary behavioral changes (startle and stress) that could decrease a fish's ability to avoid predators or delay normal migration past the work site, which is especially important if the pile driving tests extend past October 15, because CCV steelhead adults typically begin their upstream migrations with the beginning of substantial runoff flows in the Central Valley, which consistently begin to occur after mid-October. The test pile driving in 2019 is allowed to continue until November 1, because it would be short in duration, only lasting two to four days. The background RMS sound pressure levels, or effective quiet, is assumed to be 150 dB and the acoustic impact area is the area where the predicted RMS sound pressure level generated by pile driving exceeds this threshold. Once the pressure waves attenuate below this level, fish are assumed to no longer be adversely affected by pile driving sounds. Under the concept of effective quiet being equal to 150 dB_{RMS}, the distance fish are expected to be adversely affected during pile driving is out to 3,981 meters (Table 7) from the location of the pile being driven, assuming a transmission loss constant of 15 (NMFS 2008). This distance effectively covered the width of the San Joaquin River bank to bank, the San Joaquin River being approximately 250 meters in width in this section, and would be expected to propagate more than a mile up- and downstream from the pile driving location and may delay individual adult CCV steelhead in their upstream migration. Additionally, there is some bounce back from the sides of the river where the pressure waves can continue to propagate, but soft sediments and banks absorb/disrupt a lot of the sound, thus it is minimized when you consider the straight path travel.

Table 7. Threshold distances to in-water adverse effects using unattenuated maximum expected underwater sound from driving 20-inch sheet piles (205 dB peak, 179 dB SEL, 189 dB RMS), when fish weight >2 grams, modulated by strikes per day, calculated by the NMFS pile driving calculator (NMFS 2008).

Strikes per Day	**Peak (dB) ≥ 206**	**Cumulative SEL (dB) ≥187**	**RMS (dB) ≥150**
250	9 meters	116 meters	3,981 meters
500	9 meters	184 meters	3,981 meters
1,000	9 meters	293 meters	3,981 meters

Construction Pile Driving Effects

Considering the scenario which will be most acutely harmful during construction installation (36-inch diameter steel pipe piles in less than 5 meters water depth, impact pile driving in water, 5,000 strikes a day, no attenuation) with the production of 208-210 dB peak/180-190 dB SEL/177-190 dB RMS underwater sounds, the NMFS Pile Driving Calculator (NMFS 2008) indicates that the distance threshold within which instantaneous mortality would be expected to occur is 18 meters or less from the driven pile. For fish above 2 grams, the distance at which injury is expected to occur due to cumulative SEL exposure above 187 dB is within 1,585 meters from the driven pile (Table 8). The distance within which behavioral changes are expected is 4,642 meters from the driven pile, where the RMS sound will be above 150 dB RMS. SELs below 150 dB are assumed to not accumulate and cause fish injury, or be significantly different from ambient conditions, (i.e., effective quiet). If the number of strikes per day is increased to 3,200 (the maximum presented in the BA), the distances affected by injurious cumulative SELs is increased to almost the entirety of the affected area, out to 3,442 meters from the driven pile.

Pressure levels in excess of 150 dB_{RMS} are expected to cause temporary behavioral changes (startle and stress) that could decrease a fish's ability to avoid predators or delay normal migration past the work site. The background RMS sound pressure levels, or effective quiet, is assumed to be 150 dB_{RMS} and the acoustic impact area is the area where the predicted RMS sound pressure level generated by pile driving exceeds this threshold. Once the pressure waves attenuate below this level, fish are assumed to no longer be adversely affected by pile driving sounds. Under the concept of effective quiet being equal to 150 dB_{RMS}, the distance fish are expected to be adversely affected during pile driving is out to 4,642 meters (Table 8) from the location of the pile being driven, assuming a transmission loss constant of 15 (NMFS 2008). This distance effectively covered the width of the San Joaquin River bank to bank, the San Joaquin River being approximately 250 meters in width in this section, and would be expected to propagate 2.88 miles both up- and downstream from the pile driving location.

Table 8. Threshold distances to in-water adverse effects using unattenuated maximum expected underwater sound (210 dB peak, 190 dB SEL, 190 dB RMS) modulated by strikes per day, when fish weight >2 grams, calculated by the NMFS pile driving calculator (NMFS 2008).

Strikes per Day	**Peak (dB) ≥ 206**	**Cumulative SEL (dB) ≥187**	**RMS (dB) ≥150**
1,000	18 meters	1585 meters	4,642 meters
3,200	18 meters	3,442 meters	4,642 meters
5,000	18 meters	4,634 meters	4,642 meters

The underwater sound conditions in Table 9 would be expected to occur on days when in-water impact pile driving of 36-inch diameter piles occur (i.e., during the installation of the dolphins), and represent unattenuated underwater sound monitoring data. Installation of the floodgate foundation piles will occur in the dewatered area behind a cofferdam, effectively isolating the exposed portion of the driven pile and dampening any vibration's translation into the water column. However, the portion of the pile beneath the riverbed will translate vibrations through the saturated substrate sideways and up into water column outside of the cofferdam, therefore some underwater pressure waves will propagate. NMFS considers that attenuation measures, such as pile driving within a dewatered cofferdam, reduces the underwater pressure waves by 5 dB for each application. Therefore, using a reduced underwater sound estimate, driving the floodgate foundation piles the distance over which fish injury would occur is greatly reduced (Table 9).

Table 9. Threshold distances to in-water adverse effects using attenuated maximum expected underwater sound (205 dB peak, 185 dB SEL, 185 dB RMS) modulated by strikes per day, when fish weight >2 grams, calculated by the NMFS pile driving calculator (NMFS 2008).

Strikes per Day	Peak (dB) ≥ 206	Cumulative SEL (dB) ≥187	RMS (dB) ≥150
1,000	9 meters	736 meters	2,154 meters
3,200	9 meters	1,597 meters	2,154 meters
5,000	9 meters	2,151 meters	2,154 meters

The total number of days over which fish are expected to be exposed to underwater sounds above effective quiet is expected to be approximately 297 days total, based on the duration of pile driving days required, as estimated in Table 5. In-water pile driving will occur on 233 of those days, and on land pile driving will occur for approximately 64 days. The in-water work window of July 15th through October 15th is a span of only 92 days, therefore the proposed action would likely require at least three seasons of pile driving with few breaks to complete in-water work during the in-water work window, even with the high number of impact strikes (5,000 strikes) proposed per day. It is far more likely the project will take more than three in-water work seasons to complete this amount of pile driving within the work window due to holidays and weekends.

The proposed in-water work window is effective in avoiding most interactions with CV spring-run Chinook salmon, with the bulk of their upstream adult migration concluding by the end of June, in part due to summer water temperatures that often exceed their lethality threshold at this location. However, CCV steelhead adults can begin their upstream migration anytime from July through December, and sDPS green sturgeon may remain in freshwater systems feeding and rearing throughout the year. It is possible that adult CCV steelhead may use the action area as a migration corridor, while sDPS green sturgeon adults and juveniles may use the action area as foraging and rearing habitat during the in-water work window, whenever water temperatures are suitable (at least below 75°F). According to in-river monitoring data available on the California Data Exchange Center for the San Joaquin River at Garwood Bridge station, water temperatures upstream of the action area in the San Joaquin River are likely to exceed anadromous fish (CCV steelhead, CV spring-run Chinook, and sDPS green sturgeon) thermal limits regularly during the work window. Water temperatures are likely to drop in September, with atmospheric temperature drops and increased cloud cover and rainfall. In some years, water temperatures may be tolerable to anadromous fish use throughout the summer, as seen in 2011 and 2017. Therefore, CCV steelhead and sDPS green sturgeon are assumed to be present when local water temperatures are below 75°F, though the total number of individual fish using the area during the work window is expected to be low.

Due to the large area that will be impacted by elevated underwater sounds above effective quiet (2,154 to 4,642 meters from the location of the pile being driven), and the large number of days required to complete the proposed project, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are expected to be adversely affected by vibratory pile driving associated with this action. While vibratory pile driving is generally not directly injurious to fishes even when performed in water without attenuation, it is likely that the underwater pressure waves and sounds will disturb the normal behaviors of fish using this area, including potentially interrupting migration patterns and foraging activities, even while the project observes the proposed in-water and on-land work windows, and uses underwater sound control measures.

Impact pile driving is expected to directly injure or kill fishes within certain distance thresholds, depending on the size of pile being driven, the number of strikes used in a day, and whether attenuation measures are being employed. Using the greatest numbers of strikes estimated to drive the largest piles (up to 5,000), it is expected that fish greater than 2 grams may be killed within 9 meters (with underwater sound control, Table 9) to 18 meters (without underwater sound control, Table 9) of the driven pile due to in-water impact pile driving. In the same scenario, it is expected that fish greater than 2 grams may be injured within 736 meters (with underwater sound control, Table 9) to 4,634 meters (without underwater sound control, Table 9) of the driven pile due to the cumulative SELs produced by in-water impact pile driving. If in-water impact pile driving is limited to only the in-water work window (including in-river work behind a dewatered area), then CCV steelhead and sDPS green sturgeon are expected to be affected.CV spring-run Chinook salmon are not expected to be present in the action area July through October.

Acoustic Effects of Barge and Boat Traffic

Barge and tugboat traffic will create additional sources of noise in the aquatic environment. This would be an acoustic-related stressor that could result in negative impacts to listed species present. Ships under power produce a substantial amount of mechanical- and flow-induced noise from motor, propeller, and hull turbulence. Measurements of sound intensity from commercial shipping have shown sound levels up to approximately 180 dB (ref. 1 μPa) at the point source (1 meter from ship) (Kipple and Gabriele 2007). This level of noise will drop off by 40 dB at 100 yards away and approximately 53 dB lower at one quarter mile (Kipple and Gabriele 2007). The narrow confines of channels in the action area would indicate that the elevated noise levels generated by the passage of commercial vessels such as tugboats would extend essentially from bank to bank in the San Joaquin River, thus subjecting all fish within the confines of the channel to anthropogenic-produced noise conditions. The relatively rapid passage of the barge and tugboat past a given point will somewhat attenuate these effects by decreasing the duration of the elevated sound levels, but some temporary effects can be anticipated to occur, depending on the proximity of the exposed fish to the sound source. The presence of underwater noise, such as that originating with shipping, may adversely affect a fish’s ability to detect predators, locate prey, or sense their surrounding acoustic environment (Slabbekoorn et al. 2010, Radford et al. 2014). Other species of fish have been shown to respond to recorded ambient shipping noise by either reacting more slowly to predators, thus increasing their susceptibility to predation (Simpson et al. 2015, Simpson et al. 2016), or becoming hyper-alert and reacting more quickly to a visual predator stimulus, causing them to cease feeding and hide (Voellmy et al. 2014b). Voellmy et al. (2014a) states that elevated sound levels could affect foraging behavior in three main ways: noise acting as a stressor, decreasing feeding behavior directly through reduced appetite, or indirectly through a reduction in activity and locomotion and alterations to the cognitive processes involved in food detection, classification, and decision making; noise acting as a distracting stimulus, diverting an individual’s limited amount of attention from their primary task to the noise stimuli that have been added to the environment; noise masking crucial acoustic cues such as those made by both prey and predators.

Fish also may exhibit noise-induced avoidance behavior that causes them to move into less suitable habitat for foraging or will wait to feed when the noise has abated. Voellmy et al. (2014a) surmised that sustained decreases in food consumption could have long-term energetic impacts that result in reductions in growth, survival, and breeding success. Moreover, compensatory feeding activities could increase predation risks by increasing time exposed to predators or by forcing animals to feed in less favorable conditions, such as in times or areas of higher predation pressure.

Increased noise, produced by barge and tugboat traffic may result in salmonids and green sturgeon fleeing the area of those noises and moving into the channel's shallowest margins or adjacent habitat. The channel margins of many Delta waterways have submerged and emergent vegetation (e.g., Egeria) and rock rip-rapped levees where predatory species are likely to occur in greater numbers than in the open waters of the channel. This scenario therefore could increase the predation risk of salmonids, particularly smolts. Likewise, elevated noise exposure can reduce the ability of fish to detect piscine predators, either by reducing the sensitivity of the auditory response in the exposed fish or masking the noise of an approaching predator. Such would be the case if open water predators such as striped bass (*Morone saxatilis*) encounter the juvenile fish in the open channel while a barge and tug are present.

If barge traffic is limited to only the in-water work window, then only CCV steelhead and sDPS green sturgeon are expected to be affected because CV spring-run Chinook salmon should be out of the area July through October. However, because of the variability and uncertainty associated with the population sizes of the species present, annual variation in the timing of migration and variability regarding individual habitat use of the action area, the actual number of individuals present in the action area during the in-water work window is not known. However, there would be few individuals present since most juvenile salmonids would have left the action area by late spring and are least likely present in the action area during in-water work season, therefore impacts resulting from elevated noise levels from barge or tugboat are expected to be low.

Dewatering and fish relocation activities

Fish have the potential to become entrapped behind the cofferdam during the dewatering activities, resulting in injury or death, and/or require handling for relocation, which may result in injury or death. Fish capture and relocation would be necessary during dewatering activities if listed fish are present and found in the enclosed area of the cofferdam.

Each step during the capture/relocation process could also induce physiological stress even when a skilled fish biologist performs the relocation. The capture and relocation of salmonids associated with the dewatering of the cofferdam is expected to adversely affect a small number of salmonids if present in the action area. If dewatering activities only occur during the in-water work window, then only juvenile CCV steelhead and sDPS green sturgeon are expected to be affected because CV spring-run Chinook salmon should be out of the area July through October. Although upstream-migrating adult CCV steelhead and rearing or migration adult sDPS green sturgeon may occur in the project area during in-water work, the large size and probable avoidance of the enclosed area makes it unlikely that they would be trapped in the cofferdams. Juvenile green sturgeon could occur during any month in the Delta, although in small numbers in the action area.

Because of the variability and uncertainty associated with the population sizes of the species present, annual variation in the timing of migration, and variability regarding individual habitat use of the action area, the actual number of individuals present in the action area during the in-water work window is not known. However, there would be few individuals present since most juvenile salmonids would have left the action area by late spring and are least likely present in the action area during in-water work season, therefore impacts resulting from dewatering activities are expected to be low.

Habitat loss/modification

The proposed project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat. Once the fixed wall is constructed, approximately 3,400 tons of riprap (approximately 200 linear feet) would be placed along the banks at the Stockton Golf and Country Club (approximately 100 linear feet on each side of the fixed wall), as well as 230 linear feet around the tip of Dad's Point. The fixed gate wall would extend approximately 800 feet from the north tip of Dad's Point Levee to the right bank of the San Joaquin River, at the Stockton Golf and Country Club. The walls would be constructed to be between approximately 29 feet apart at the connection between cells and 34 feet apart at the widest part of each cell, and would have a top elevation of 15.0 feet, extending 10 feet above the mean water level at the entrance to Smith Canal.

The placement of the gate structure and habitat occupation by artificial material (riprap) in the San Joaquin River can result in adverse effects to listed fish. The action area is a major migratory corridor for juvenile and adult listed fish. The placement of the permanent floodwall gate would not impede fish passage, but it would occupy a portion of the area adjacent to the San Joaquin River (Smith Canal) and could have some operation and maintenance effects on migrating fish. The placement of the permanent gate structure could result in an increase in predation and prey on juvenile listed salmonids when migrating through the action area. The action area currently does not provide suitable aquatic riparian habitat, but the modification and placement of riprap would preclude in its footprint any potential for future riparian vegetation to grow that would provide shelter and resting areas for migrating juveniles. The intent of riprap is to stabilize stream channels and limit natural fluvial processes. The reduction of the erosion and consequent deposition cycle, naturally inherent to all alluvial channels, eliminates a channel's ability to maintain bedforms for salmonid habitat and impairs the ability for a stream to be maintained in a dynamic steady state. This alteration of the aquatic ecosystem has diverse deleterious effects on aquatic communities, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling et al. 2001). Riprap does not provide the intricate habitat requirements for multiple age classes or species similar to natural banks, or banks that include instream woody material (Peters et al. 1998).

Therefore, adverse effects resulting from permanent habitat loss/modification to listed fish are expected to occur. Since it is impossible with the currently available monitoring data to determine how many individual fish will be taken through the loss or modification of the habitat, NMFS will use the values for lineal feet of aquatic habitat impacted and lost on waters bearing NMFS' listed species as ecological surrogates for the detrimental effects upon listed fish.

Long-term Operations and Maintenance

According to the construction sequence for the proposed action, the gate structure would be constructed in Year 1 of the project from July to March (after the cofferdam is installed) in the dry. The gate is a 50-feet wide mitered double-door metal structure that when open extends outward into the San Joaquin River. The purpose of the gate when closed is to provide a tool for flood control when the San Joaquin River reaches a water surface elevation of 8.0 feet, North American Vertical Datum of 1988 [NAVD88]. Isolating Smith Canal and the 15,000 residents identified in a designated FEMA 100-year floodplain, will meet the Central Valley Flood Protection Act of 2008 which requires a 200-year flood protection by 2025 for urban and urbanizing areas.

Typically, the gates would be operated (closed) under specific conditions during the rainy season and during times when high tides occur in the area. Generally, extreme high tides and floods associated with the rainy season occur between November 1 and April 30. The gate will typically be operated only during extreme high tides and flood events when the water elevation exceeds + 8.0 feet (NAVD 88) in the channels containing the gates, or when operated for maintenance purposes. When operated for forecasted high tides above +8.0 feet, the gates will be closed on the lowest tide prior to the predicted high tide, typically within a 24-hour period. The gates will not be opened until the high tide elevation drops below +8.0 feet, thus allowing any accumulated water behind the gate to flow out. The Corps predicts that the duration of the gate closures for extreme high tides should not last more than 6 to 12 hours per a high tide event. They further state that the closures related to extreme high tides will occur approximately 10 times a month during the months of January and February, and rarely will two extreme tides occur within a 24-hour period. On these rare occasions, the gates may remain closed for more than 24 hours.

The gate is controlled by programmable preset operating controls housed in a fixed building on Dad's Point adjacent to the fixed wall tie-in. A second set of controls may be installed at the end of the sheet pile wall near the shore and a portable generator will be used in the event of a power outage. Included in building the gate structure is the construction of a cofferdam to isolate the work are from the San Joaquin River. The cofferdam will be installed using a vibratory pile driver. The cofferdam will be built first and will take approximately 1-month to construct and will be part of the Year-1 construction activities. Following its completion, construction activities will begin on the gate structure and take approximately 6 months to complete. The first step will be to drive 64 concrete-filled steel pipe piles that are 36-inches in diameter along the inside edge of the cofferdam to provide support for the concrete floor and walls.

During the long-term period of gate operations, the narrow gate opening (~50 feet) will create higher velocity flow through the structure than currently exists through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

Effects of turbidity on fish and aquatic habitat

Resuspension of contaminated sediments may have adverse effects upon salmonids or sDPS green sturgeon that encounter the sediment plume, even at low turbidity levels. Lipophilic compounds in the fine organic sediment, such as toxic PAHs, can be preferentially absorbed through the lipid membranes of the gill tissue, providing an avenue of exposure to salmonids or sDPS green sturgeon experiencing the sediment plume (Newcombe and Jensen 1996). Such exposures to PAHs have been linked with declines in the immune systems of exposed fish as well as damage to genetic material through formation of breaks or adducts on the DNA strands. Similarly, charged particles such as metals (*e.g.*, copper), may interfere with ion exchange channels on sensitive membrane structures like gills or olfactory rosettes. This reduces the sensitivity of fish to detect smells or chemical cues in their environment and may interfere with ion exchange metabolism across cellular membranes necessary for osmoregulation. Increases in ammonia from the sediment may create acutely toxic conditions for salmonids or sDPS green sturgeon present in the channel's margins.

An increase in flow velocity due to gate operations between November 1 and April 30 overlaps with species run timing and adds to the probability of potential exposure of listed salmonids and green sturgeon to effects of higher levels of turbidity.

Effects Related to Long Term Operations of the Flood Control Gates

These episodes of extreme tides create larger than normal movement of waters in the Delta and may stimulate adult fish holding in the Delta to move upstream to spawn. When the gates are operated, any fish moving with the increased tidal activity may enter the waterways behind the gates on prior tides and become trapped by the closed gates. However, fish trapped behind the closed gate would typically be detained for less than 24 hours, and usually only for 6 to 12 hours.

Fish trapped behind the gate will have typically short-term exposures to the waters behind the gates, and any deleterious water quality issues or predator populations that may exist there. Any fish caught behind the gates cannot leave the area of degraded water quality until the gates are reopened, and thus are exposed to any negative conditions existing for the duration of the closure. The short duration of exposure is probably not sufficient to cause direct mortality from any contaminants that might be present, but sublethal effects may start to manifest themselves even with exposures of only a few hours. Smith Canal, as well as several waterways draining to the eastern Delta in the action area, are listed under the EPA's 303(d) listing of impaired water bodies in California (State Water Resources Control Board 2010) containing elevated levels of organic materials, pesticides, heavy metals, and pathogens, as well as many other constituents that impair water quality. Furthermore, it is unclear how the physical barriers will affect the level of contaminants in the impacted waterways, but it is likely to degrade water quality over the long run by preventing dilution and muting tidal exchange with the larger Delta. Finally, when fish are trapped behind the gates, they become susceptible to predators that may reside in the waterways behind the gate. Entrapped fish will be exposed to these predators for the duration of the gate closure with a reduced avenue of escape through the narrow gate opening. Fish such as CCV steelhead smolts and juvenile CV spring run Chinook salmon are highly vulnerable to predation by predators such as striped bass (*M. saxatilis*) or largemouth bass (*Micropterus salmoides*) that may also occupy the waters behind the gates.

Adult CV spring-run Chinook salmon and CCV steelhead are less likely to be predated upon, unless marine mammals such as California sea lions (*Zalophys californianus*) also are present in the waterways when they are closed off. Sea lions are known to occur within the Stockton DWSC leading to the Port of Stockton and are likely to be present near the Smith Canal gates.

The Corps has indicated that if necessary the gates will be closed for an extended period during flood conditions particularly when they are coupled with high tides. If flood conditions, either by themselves or in combination with high tide events, raise the water elevation to greater than +8.0 feet NAVD 88, the gates will be closed until the water elevation recedes below +8.0 feet. Records show that the high water conditions may last several days. As indicated above, there is the potential for listed fish to be trapped behind the flood control gates when they are closed. Under flood conditions, the longer duration of gate closures will expose fish to longer periods of degraded water quality or predation within the enclosed water bodies. Furthermore, flood conditions usually coincide with increased precipitation events that create surface runoff from upland areas. This results in increased stormwater flows into waterbodies such as Smith Canal and the sloughs feeding into other waterways. Stormwater runoff has the potential to be heavily contaminated with organic materials (which decrease DO content in the water), petroleum products and heavy metals from roadways, pathogens, and pesticides. Stormwater is cited as a source for these contaminants in Smith Canal (State Water Resources Control Board 2010).

Elevated contaminant loads coupled with longer exposure periods will increase the likelihood of sublethal and lethal effects on exposed fish. Furthermore, increased durations of gate closure will expose any listed fish trapped behind the gates to longer periods of predation risk in those waters. Periods of high runoff that could trigger longer gate closures usually occur in the winter and spring seasons. This period overlaps with the migrations of adult and juvenile CCV steelhead in the San Joaquin River basin. Likewise, adult and juvenile CV spring-run Chinook salmon from the experimental population and their future progeny would be migrating through the San Joaquin River adjacent to the Smith Canal flood control gates during the late winter and spring periods. There is also an increased potential for adult sDPS green sturgeon to begin movements upstream into the San Joaquin River in response to increased flows in the mainstem of the river and its tributaries. Movements of juvenile sDPS green sturgeon in the Delta may also be enhanced by increases in river flows and increased turbidity.

It is uncertain what the risk to the populations of listed fish will be due to entrapment behind the gates. If the gates remain closed for extended periods of time, then no additional fish will be exposed to entrapment due to gate operations. However, any individual fish that is trapped behind the closed gates will be vulnerable to increased mortality with prolonged closures. In contrast, more frequent gate operations expose more individual fish to the effects of the flood control structure, but the duration of their captivity is shorter, and lethal effects are less likely to occur due to exposure to contaminants and predation. Although there is significant risk to any individual fish trapped behind the gates, the risk to the population depends on the proportion of the population moving past the gates at the time the gates are closed and what fraction of that number is actually behind the gates when they are operated. This level of detail is currently unknown.

Risks to fish are not limited to being entrapped behind the gates when they are closed. The construction of the flood control gates and the accompanying flood wall create a barrier to the free exchange of water into the Smith Canal waterway during the daily tidal cycle. The relatively narrow opening of the gates (50 feet) compared to the width of the unobstructed channel will create a region of high velocity flows through the gate openings with each tidal change in water surface elevation. This zone will be bi-directional as a result of the changes in tidal elevation; flow will move from the area of higher water elevation to the area of lower water elevation depending on the stage of the tide. On the flood tide, water elevations will be increasing on the outside of the gate structures relative to the inside of the gate structures and water will flow up-channel through the narrow gate opening into the area behind the gates at increasing velocity due to head differentials between the two sides of the gate structure. Flow through the gates will diminish as the two water elevations reach equilibrium at high tide. When the tide changes to ebb, the water inside the flood structure will be higher than the water elevation outside and remain so for a longer period of time due to the gate constriction. The flow will now go in the reverse direction through the gate at high velocities.

The creation of a high velocity stream through the gate opening creates a field of velocity shears and their resulting eddies and turbulence along the boundary between high velocities and low velocities on the down current side of the gate. The region of velocity shears and turbulence creates favorable habitat for predators to hold and feed on prey as the prey moves through the high velocity stream. This is particularly true when the flood structure creates vertical structure for predators to orient to immediately adjacent to the higher velocity flow, and hold station outside the higher velocity flows without physically exerting themselves to remain in the favorable feeding locations. The structure also creates shade and obscures the presence of the predators holding against the vertical sheet pile wall, creating an increased risk of predation for smaller sized fish such as juvenile CV spring-run Chinook salmon and CCV steelhead smolts that are entrained in the fast moving stream of water going through the gate opening. This condition will occur typically four times a day with each change of the tide while the gates are open.

In addition to the creation of the high velocity flows through the gate openings and increased predation risks, the flood-gate structures also are likely to degrade water quality conditions inside the waterways when the gates are closed. The presence of the gates will reduce the free exchange of water within the waterways they block with the larger Delta system. This will reduce the volume of water exchanged on each tidal cycle with the larger Delta water volume and increase the residence time of the water behind the gate structures and flood wall. This situation is likely to allow contaminants behind the flood structure to increase in concentration since they are not being flushed out of the system as fast as the pre-gate conditions allowed. Finally, without appropriate modeling, NMFS cannot predict what the magnitude of the water quality changes will be, however the changes are expected to occur under all water elevations, and be exacerbated when the gates are closed.

In summary, the long-term operations of the flood control gates on Smith Canal will create barriers to the free movement of individual fish moving within close proximity to the gates and may cause fish to become entrained behind the closed gates. Listed fish that enter through the narrow gate opening will be subject to increased predation risk and exposure to degraded water quality conditions. The gate structures will also create physical conditions that decrease the value of the habitat adjacent to these structures. Diminished circulation will decrease flushing flows through these waterbodies, potentially allowing any contaminants discharged into the waterbody behind the structures to increase in concentration and not be transported away from the confined waterbodies. The narrow gate opening will create hydraulic conditions that will favor predatory fish, which will be attracted to the open water structure created by the flood barrier. Both of these physical conditions will increase adverse effects to listed fish exposed to them. These conditions will be present at all water elevations to some extent as described above.

2.5.2 Project Effects on CCV steelhead and sDPS green sturgeon Critical Habitat

The project is expected to adversely impact several PBFs of critical habitat for CCV steelhead (freshwater rearing habitat and freshwater migration corridors) and sDPS green sturgeon (food resources, water quality, water depth, and migratory corridors).

The proposed project is expected to cause direct short- and long-term, and permanent effects on critical habitat for CCV steelhead and sDPS green sturgeon. Potential project effects include temporary water quality degradation from localized increases in turbidity and suspended sediment, permanent habitat loss/modification of critical habitat, and in-channel disturbance from pile driving and placement of the tidal gate. Long-term direct effects on designated critical habitat are expected to result in potential decrease in survival of fish due to increased predation in the action area and impacts from the operations of the tidal gate and fish becoming entrained behind the gate.

Poor water quality and elevated contaminant concentrations due to low water exchange rates can impact salmonids, particularly juveniles that rear in these waters year-round and consume prey exposed to the contaminants such as sDPS green sturgeon. The prey base (green sturgeon food resources) are likely to bioaccumulate some of the contaminants listed in the 303(d) list for impaired waters that are present in the Smith Canal, as green sturgeon are bottom feeders. Alternatively, prey populations may be diminished due to mortality related to the contaminants present or perhaps a combination of diminished prey populations with the remaining prey populations bearing contaminant loads that are then transferred to the green sturgeon that consume them. Green sturgeon that consume contaminated prey may incur sublethal or lethal effects depending on the load and type of contaminates consumed.

The placement of the tidal gate will extend 800 linear feet from the tip of Dad’s Point levee to the right bank of the San Joaquin River. In addition, 200 linear feet of riprap will be placed on the banks of Stockton Golf and Country Club. Therefore, the project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat.

The habitat found in this portion of the San Joaquin River is characterized as a relatively deep, medium velocity channel, with silt and sand substrate. The action area does not include salmonid spawning habitat; however, adult and juvenile CCV steelhead use the area as a migratory corridor and juvenile CCV steelhead likely use the area for rearing during their downstream migration. Foraging adult and juvenile sDPS green sturgeon may be present in the action area but in low numbers.

While the sandy substrate in the vicinity of the proposed project provides some submerged aquatic and emergent vegetation, it is not currently favorable rearing habitat for salmonids due to the lack of shaded aquatic habitat and habitat complexity. However, placement of permanent infrastructure would prevent improvements to provide more suitable habitat for listed species. In addition, the placement of riprap for scour protection is expected to decrease habitat quality for salmonids, as warm-water predatory species (such as bass) would be likely to occupy this habitat post-construction.

Because the proposed project will occupy some amount of CCV steelhead and sDPS green sturgeon critical habitat, a purchase of compensatory mitigation credits is included as part of the proposed action to offset this impact to some degree. SJAFCA will purchase salmonid credits at a 3:1 ratio from a NMFS approved mitigation bank. SJAFCA will purchase 2.46 credits for the loss of 0.82 acres of tidal perennial habitat and 2.49 credits for the loss of 0.83 acres of riparian habitat.

The purchase of compensatory mitigation credits will restore and preserve, in perpetuity, shaded riverine aquatic habitat or similar types of riverine habitat that will be beneficial to salmonids. The mitigation banks that serve the action area offer floodplain or other habitat that can support migrating juvenile and adult CCV steelhead and sDPS green sturgeon in the same way that river margin habitat otherwise would have, had the project not occurred. Shaded riverine habitat types of conservation credits can benefit both adult and juvenile CCV steelhead and sDPS green sturgeon, even if such banks are located far from the action area and individuals affected by the project would be unlikely to benefit from the compensation purchase.

The purchase of credits provides a high level of certainty that the benefits of a credit purchase will be realized because each of the NMFS-approved banks considered in this biological opinion have mechanisms in place to ensure credit values are met over time. Such mechanisms include legally-binding conservation easements, long-term management plans, detailed performance standards, credit release schedules that are based on meeting performance standards, monitoring plans and annual monitoring reporting to NMFS, non-wasting endowment funds that are used to manage and maintain the bank and habitat values in perpetuity, performance security requirements, a remedial action plan, and site inspections by NMFS. In addition, each bank has a detailed credit schedule, credit transactions, and credit availability that are tracked on the Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS). RIBITS was developed by the Corps, with support from the Environmental Protection Agency, the UUSFWS, the Federal Highway Administration, and NMFS to provide better information on mitigation and conservation banking and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, service areas, as well as information on national and local policies and procedures that affect mitigation and conservation bank and in-lieu fee program development and operation. RIBITS also contains links to bank establishment documents. The Bullock Bend Mitigation Bank was established on June 23, 2016; the Cosumnes Floodplain Mitigation Bank was established on August 4, 2008; the Fremont Landing Conservation Bank was established on October 19, 2006; and the Liberty Island Conservation Bank was established on July 21, 2010.

2.6 Cumulative Effects

“Cumulative effects” are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area’s future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

The private and state activities described below are likely to adversely affect CV spring-run Chinook salmon, CCV steelhead, sDPS green sturgeon, and designated critical habitats for CCV steelhead and sDPS green sturgeon. These potential factors are ongoing and expected to continue into the future. However, the extent of the adverse effects from these activities is uncertain, and it is not possible to accurately predict the extent of the effects from these future non-Federal activities.

2.6.1 Agricultural Practices

Agricultural practices in the action area may adversely affect riparian habitats through upland modifications of the watershed that lead to increased siltation, reductions in water flow, or agricultural runoff. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which can flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonids reproductive success and survival rates (Dubrovsky et al. 1998, Daughton 2003).

2.6.2 Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth would place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, would not require Federal permits, and thus would not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially would degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.6.3 Rock Revetment and Levee Repair Projects

Depending on the scope of the action, some non-federal riprap projects carried out by state or local agencies do not require federal permits. These types of actions as well as illegal placement of riprap occur within the watershed. The effects of such actions result in continued degradation, simplification, and fragmentation of riparian and freshwater habitat.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review. Therefore, we concluded that CCV steelhead should remain listed as threatened, as the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Further, there is still a general lack of data on the status of wild steelhead populations. There are some encouraging signs, as several hatcheries in the Central Valley (such as Mokelumne River), have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percent of wild fish in those data remains much higher than at Chipps Island. Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San

Joaquin River Basin continue to show an overall very low abundance, and fluctuating return rates. The NMFS Recovery Plan (NMFS 2014) strategy for CCV steelhead lists the San Joaquin River's eastside tributaries (Stanislaus, Tuolumne, and Merced rivers) as Core 2 populations (meaning these watersheds have the potential to support viable populations, due to lower abundance, or amount and quality of habitat) downstream of major dams, and as candidates to reach viable population status if reintroduced upstream of the dams, and lists the San Joaquin River, below Friant Dam, as a candidate to reach viable population status. The action area serves as a migratory corridor to these eastside tributaries.

NMFS finds that the operation of the Smith Canal flood gate is unlikely to substantially affect the population of CCV steelhead moving past the Smith Canal flood control gates. Gates will be operated for approximately 17 percent of the time in January and February when adults may be moving upriver to spawning grounds, leaving the gates open for 83 percent of the time. The majority of adults are expected to migrate upriver in December and January with the run tapering off quickly in February and March. The gate operations for tides overlaps with a significant proportion of the adult spawning run, however, there is low probability of CCV steelhead being attracted into Smith Canal due to a lack of any tributary inflow, although some false attraction may be created by the high velocity currents described above as a result of tidal elevation differentials. The duration of any entrapment for adults in response to tidal operations will typically be brief (usually lasting no more than 6 to 12 hours per a high tide event), and exposure to contaminants should not result in mortality. CCV steelhead smolts are not likely to be emigrating downriver at the time that gates are being operated for the high tides. Therefore, there is a low risk of smolts being entrapped by the gates closing. Gate closures for high water events due to high inflows will result in an average of three closures per year, meaning that there are only that many gate closures to entrap adults or juveniles. While the fish trapped behind the gates for flood closures are likely to be lost to the population, there are no new fish being entrapped by gate operations on additional days while the gates remain closed.

As already discussed for CV spring-run Chinook salmon, the number of fish present when the gates are closed, and subsequently trapped behind the closed gate, is unlikely to represent a substantial proportion of the population present in the system, thus impacts to the entire population are minimal. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CCV steelhead in the DPS. The low impact of the Smith Canal gate to the CCV steelhead population in the San Joaquin River basin over the foreseeable future will not substantially affect the larger CCV steelhead population and will not negatively affect its viability.

2.7.2 Status of the CV spring-run Chinook salmon

The CV spring-run Chinook salmon ESU is also listed as threatened under the ESA but is considered extirpated from the San Joaquin River Basin (NMFS 2016). The NMFS 2016 5-Year Status Review re-evaluated the status of CV spring-run Chinook salmon and concluded that the species should remain listed as threatened (NMFS 2016a). Through recovery plan implementation and SJRRP reintroduction efforts (SJRRP, 2018), reintroduced CV spring-run Chinook salmon are expected to use the action area. One of the primary reasons these fish species are listed under the ESA is the ubiquitous artificial modifications to, and destruction of, crucial freshwater habitat and the services it provides in the Central Valley (NMFS 2016a). This threat currently persists and is expected to grow as human populations, land development and freshwater demands increase in California. Such trends are likely to suppress the recovery potential of these populations, despite recovery efforts, based on the effective scale of adverse habitat changes compared to recovery actions. The NMFS Recovery Plan (NMFS 2014) indicated that for CV spring-run Chinook salmon, re-establishing two viable populations in the San Joaquin River Basin would be necessary for recovery. The action area is a migratory corridor to the upper reaches of the San Joaquin River, below Friant Dam.

Gates will be operated for approximately 17 percent of the time in January and February when a few adults may be moving upriver to spawning grounds. The majority of adults are expected to migrate upriver later in the year. Few CV spring-run Chinook salmon juveniles or smolts would be expected to be moving downstream at this time past the Smith Canal flood gate location, thus exposure to the tidal operations are limited. Some individuals may be present and subsequently entrapped by the operations of the gates and lost. The gates may be closed for approximately 12 percent of the operating season (3 weeks out of 25 weeks; November through April) but will only amount to three gate closures per year on average. Thus, there are only three events per year that will trap fish behind the gates. It is unlikely that these three closure events will overlap with a substantial proportion of the population being present at the gate when it is closed. While the gates are closed during high water events, juvenile and adult fish in the DWSC are unaffected by the presence of the gate structure. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CV spring-run Chinook salmon in the ESU. The low impact to the CV spring-run experimental population and its progeny over the foreseeable future will not substantially affect the larger CV spring-run Chinook salmon ESU population and will not negatively affect its viability.

2.7.3 Status of the sDPS green sturgeon

The federally listed sDPS green sturgeon and its designated critical habitat occur in the action area and may be affected by the proposed action. It was listed as threatened in 2006 and its designated critical habitat in 2009. Adult sDPS green sturgeon potentially migrate through the action area to reach upstream riverine habitat based on catches of sDPS green sturgeon in the San Joaquin River mainstem, upstream of the Delta (CDFW sturgeon report card data). Juvenile sDPS green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (Allen and Cech 2007). Juvenile and subadult sDPS green sturgeon may rear in freshwater and brackish water for up to three years in the Delta. During laboratory experiments, juvenile sDPS green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile sDPS green sturgeon were captured over summer in shallow shoals (1-3 meters deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats in other Delta region waterways. There is a strong need for additional information regarding sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology. The upstream portion of the San Joaquin River is not known to currently host sDPS green sturgeon spawning; therefore, the San Joaquin River Basin is not a main focus of their recovery plan. Though the sDPS does utilize the lower San Joaquin River and the discovery of an individual adult in the Stanislaus River October 2017 highlights that passage for adults is possible during certain river conditions, the recovery plan and efforts are not likely to be modified unless adult spawning or juvenile reproduction occurs (NMFS, 2018).

NMFS finds that the operation of the Smith Canal flood gate is not likely to substantially affect the population of sDPS green sturgeon in the Central Valley. The gates will be operated when both juvenile and adult sDPS green sturgeon may be present in the vicinity of the gate structure. Individual fish may be present in the DWSC and potentially on the flats in front of the gates and thus may become vulnerable to entrapment behind the gates when they are closed. Some of these individuals may be lost to the population. However, available information indicates that sDPS green sturgeon are present in low densities and numbers in this area of the Delta based on the low numbers of fish catches on the CDFW sturgeon report cards, compared to other areas of the Delta. The majority of reported sDPS green sturgeon catches in monitoring efforts and sport fishing catches indicate that sDPS green sturgeon utilize other areas of the Delta and Sacramento River watershed for their life history needs, rather than the DWSC in the Port of Stockton. Using the same reasoning as given for CV spring-run Chinook salmon and CCV steelhead, there is a low likelihood of trapping green sturgeon behind the gates due to the low frequency of gate closures overall, compared to the time they are open, and the low numbers of fish present. The loss of the few individual fish that are trapped behind the gate when it is closed will not substantially affect the overall population of green sturgeon in the Central Valley and should not impair the viability of the DPS.

2.7.4 Status of the Environmental Baseline and Cumulative Effects in the action area

The listed salmonids use the action area as a primary migratory corridor. For CCV steelhead and CV spring-run Chinook, the San Joaquin migratory corridor is an essential piece of the recovery strategy (NMFS 2014), which provides for two viable populations for each species to be established in the San Joaquin River Basin. The San Joaquin River Basin is not the main focus for sDPS green sturgeon recovery plan. Currently, the San Joaquin River, although degraded due to levees and lack of floodplain habitat, is a important migratory corridor for the recovery of these species.

The Cumulative Effects section of this Opinion describes how continuing or future effects such as the discharge of point and non-point source chemical contaminants discharges and increased urbanization affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of migratory corridors.

2.7.5 Summary of Project Effects on listed species

1) Construction-related Effects

During construction, some behavioral effects as well as injury or death to individual fish is likely to result from placement of the gate structure. Construction activities would occur during the summer and early fall months, when the abundance of individual fish is low and outside of most of the migrating adult and juvenile timing period, which would result in correspondingly low levels of injury or death. In addition, during construction activities, some water quality impacts may occur such as sediment and turbidity, but with the implementation of mitigation measures, impacts would be minimized to listed species.

2) Long-term Operations and Maintenance Effects

All species considered in this consultation would be present at some point in time when the Corps anticipates the gate would be operated to protect against high water events (November 1 through April 30). All species would be affected by the poor water quality behind the flood control gates in Smith Canal if entrapped by the operations of the gate for flood protection. NMFS expects that water quality would degrade in the future due to a decrease in tidal flushing of the Smith Canal waterway and an increase in the residence time of water behind the sheet pile walls due to the obstruction of the channel. Salmonids and sturgeon tend to be sensitive fish species to reduced water quality compared to other fish species, particularly non-native species. It is uncertain what fraction of the listed fish populations would be present when the gates are operated, and of that fraction present, how many would be entrapped behind the gates. It is certain that those fish trapped behind the gates would be exposed to more highly degraded water quality conditions than those fish remaining outside the gates, and would likely have a higher risk of predation while remaining behind the gates. NMFS assumes that fish trapped behind the gates are likely to die in the enclosed area. The risk presented to the populations of listed CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon by the long-term operations and presence of the Smith Canal flood control structure is uncertain. The proportion of the populations that will come in contact with the gate structure as fish migrate through the DWSC is unknown, since neither the spatial distribution of fish across the channel nor the use of the shallow bench along the northern river bank by the different fish species and life stages is known. However, it is certain that the gate structure enhances the risk to passing salmonids and green sturgeon above the current conditions and therefore should be considered as adversely affecting the populations of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon in the action area.

2.7.6 Summary of Project Effects on CCV steelhead and sDPS green sturgeon critical habitat

Within the action area, the relevant PBFs of the designated critical habitats for listed CCV steelhead are migratory corridors and rearing habitat, and for sDPS green sturgeon the six PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality.

Based on the effects of the proposed project described previously in this biological opinion, the impacts to the designated critical habitat diminish the value of the designated critical habitat for both CCV steelhead and sDPS green sturgeon. The quality of the current conditions of the PBFs for CCV steelhead and sDPS green sturgeon in the action area are poor compared to historical conditions (pre-levees). The habitat does not provide the functionality of the conservation values necessary for the long-term survival and recovery of the species. In particular, levees, riprapping, and removal of riparian vegetation have greatly diminished the value of the aquatic habitat in the action area by decreasing rearing area, food resources via food-web degradation, and complexity and diversity of habitat forms necessary for holding and rearing (channel and bathymetry diversity). Perpetuating levee structures with armored riprap and the addition of the proposed permanent installation of the gate structure, would continue to degrade the status of the designated critical habitat into the foreseeable future.

The temporary construction impacts to designated critical habitat would negatively affect the ability of CCV steelhead and sDPS green sturgeon to use the action area as rearing habitat and as migratory corridors during the overlap of migration periods and construction as discussed in the effects to species section. Construction effects would last for a period of several weeks, but would not permanently modify critical habitat function as noise and turbidity would end after construction ends.

The impacts of the Smith Canal flood control gate would permanently create an obstruction to migration through entrapment of fish and water quality issues. However, the flood control structure is not expected to substantially impede overall migration through the main migratory corridor of the San Joaquin River for listed species. The flood control structure is located along the opening of Smith Canal off of the San Joaquin River. The presence of the gate structure will continue into the foreseeable future, thus creating a perpetual source of poor water quality and predation impacts to the action area, and a permanent adverse effect to the listed species. The frequency of closure for short-term operations (tidal) is estimated to occur approximately 10 times a month during January and February, but gate closures should last no more than 6 to 12 hours. Taking the maximum closure time of 12 hours and a closure frequency of 10 times per month in January and February, the gates will be closed approximately 17 percent of the time during these two months. For flood events, the Corps has estimated that the gates will be closed on average three times a year from a few days to a few weeks based on the past 20 years of hydrology records. If the gates are closed for 3 weeks every year for high water elevations due to tides and inflow, then the gates are closed approximately 12 percent of the time out of 25 weeks (November through April).

2.7.7 Mitigation Bank Credits

The Corps' mitigation credit purchase is expected to mitigate some of the impacts from the Smith Canal gate project, by providing some benefits to the CCV steelhead DPS by improving riverine or floodplain habitat conditions elsewhere through restoration and ensuring their preservation into the future. The benefits offered to these populations are expected to exist in perpetuity. Although some of the banks that cover the action area in their service area may not technically offer sDPS green sturgeon credits, we expect that some sDPS green sturgeon individuals should benefit from the purchase of credits from these banks since individuals should be able to access the purchased riverine habitat areas created and maintained by the banks/programs.

2.7.8 Summary

Combining the adverse and beneficial effects (compensatory mitigation) associated with the proposed action described above, environmental baseline, cumulative effects, and status of the species and critical habitat, the project is not expected to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing their numbers, reproduction, or distribution; or appreciably diminish the value of designated critical habitat for the conservation of the species.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the Proposed Action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon, or destroy or adversely modify designated critical habitat for CCV steelhead and sDPS green sturgeon.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 Amount or Extent of Take

NMFS cannot, using the best available information, quantify and track the amount or number of individuals that are expected to be incidentally taken per species because of the variability and uncertainty associated with the population sizes of the species, annual variation in the timing of migration, and variability regarding individual habitat use of the action area. However, it is possible to express the extent of incidental take in terms of ecological surrogates for those elements of the proposed action that are expected to result in incidental take.

These ecological surrogates are measureable, and the Corps can monitor the ecological surrogates to determine whether the level of anticipated incidental take described in this incidental take statement is exceeded.

In summary, the best available surrogates for the amount and extent of take for the proposed action is as follows:

- ***Construction-related turbidity*** **–** The surrogate for turbidity increase (in NTU) is 50 NTUs higher than NTU background levels measured upstream of the project. Within the already established 1000-feet disturbance surrogate, San Joaquin River water should be no more than 50 NTU above the turbidity level in upstream measurements.

- ***Pile Driving* –** The extent of take surrogate for piling driving is 150dB RMS behavioral threshold exceeded no more than 2,154 meters from the pile, 187 dB cumulative SEL threshold exceeded no more than 1597meters from the pile, and peak 206 dB threshold exceeded no more than 18 meters from the pile.

- ***Barge and boat traffic noise* –** The extent of take surrogate for underwater noise from barge and boat traffic is the observation of erratically behaving fish, within 500 feet of construction activity in adjacent waterways during any 24 hour period.

- ***Capture of juvenile fish during in-water work area isolation* -** The size of the cofferdam and fixed wall area (800 linear feet) will serve as the surrogate for harm. During fish capture/handling/relocation process, total immediate mortality is expected to be equal to or less than 3% of relocated fishes. If this overall mortality level, or size of the cofferdam is exceeded, the proposed action will be considered to have exceeded anticipated take levels.

- ***Operations and Maintenance of the flood gate* –** Operations of the gates at water elevations greater than +8 feet NAVD88, would occur during the period from November 1 through April 30. The frequency of gate operations is defined by the water elevation and is used as a surrogate for the exposure of fish to entrapment behind the gates. Take would be exceeded if the gates are operated when the water is less than +8 feet NAVD88.

2.9.1.1 Incidental take associated with water quality (elevated in-river turbidity plumes and disturbance)

NMFS expects that during the in-water work window of mid-July through mid-October for 2020-2021 seasons and to November 1 for 2019 season, there would be turbidity related effects as a result of the project to listed species present. NMFS expects that these species and life stages to be present during the in-water work window:

- Adult CCV steelhead
- Adult and juvenile sDPS green sturgeon

The most appropriate threshold for incidental take consisting of fish disturbance and sub-lethal effects associated with elevated in-river turbidity plumes is an ecological surrogate of the amount of increase in downstream in-river turbidity generated by dredging, riprap, or pile driving related activities. In-river pile driving, dredging, and riprap placement are expected to mobilize sediment and increase water turbidity beyond natural levels to some degree. Increased turbidity is expected to cause harm to listed species present through elevated stress levels and disruption of normal habitat use. These temporary responses are linked to decreased growth, survivorship, and overall reduced fitness as described for underwater noise avoidance.

The surrogate for turbidity increase is based on salmonids sensitivity to raised turbidity levels. Typical background turbidity in the San Joaquin River during the in-water work season is approximately 25 to 80 NTU (CDEC 2018). Fifty NTUs is above the range at which salmonids experience reduced growth rates but below the range, salmonids would be expected to actively avoid the area. Therefore, the surrogate for turbidity increase is 50 NTUs higher than NTU background levels measured upstream of the project. Turbidity shall be measured immediately downstream of the boundary already established for the action area and construction noise/pile driving disturbance surrogate (1000 feet in the San Joaquin River waterway from the northernmost boundary of the construction footprint) (SJAFCA 2018). Within the already established 1000-foot disturbance surrogate, San Joaquin River water should be no more than 50 NTUs above the turbidity level in upstream measurements. Since in-river values change daily, the upstream comparison value must therefore be taken daily, in association with the downstream readings. Exceeding these turbidity thresholds will be considered as exceeding the expected incidental take levels.

2.9.1.2 Incidental take associated with pile driving

During the two years of construction that it will take to complete pile driving activities associated with the project, NMFS expects these species and life stages to be present during the pile driving portion of the construction in-water work window from mid-July to mid-October for 2020-2021 seasons and to November 1 for 2019 season only:

• adult CCV steelhead
• adult and juvenile sDPS green sturgeon

Quantification of the number of fish exposed to the pile driving associated noise and turbidity is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise. Only the level of acoustic noise generated during the construction phases can be accurately and consistently measured, thus providing a quantifiable metric for determining incidental take of listed fish. Therefore, the measurement of acoustic noise generated during the construction phase, and in particular the vibratory and impact pile driving described in the proposed project, will serve as physically measurable surrogates for the incidental take of listed fish species. NMFS assumes that the Corps will adhere to the project description provided for the purposes of the section 7 consultation, and will not depart from that description in any meaningful or demonstrable way.

The most appropriate threshold for incidental take consisting of fish displacement, behavior modification, injury, and death associated with elevated underwater noise is an ecological surrogate of the amount of habitat affected by elevated underwater noise and vibration within a certain distance from the construction site. Elevated noise disturbance is also expected to elevate fish stress levels even when no observable behavior changes are made, and are expected to decrease individual's overall fitness and survival through compounding sub-lethal effects.

Vibratory pile driving is expected to produce underwater pressure levels over 150 dBRMS out to 2,154 meters from the location of the pile driving sites. Though underwater sound levels are not expected to injure or kill fish directly, since the sounds will be above the effective quiet threshold, they are expected to cause disruption of normal habitat utilization, stress, and elicit temporary behavioral effects in CCV steelhead and sDPS green sturgeon juveniles and adults leading to harm as described below. Any behavioral alterations in juvenile fish are expected to decrease their fitness and ultimate survival by decreasing feeding opportunities, which will decrease their growth, and by causing area avoidance which will delay their downstream migration and increase their predation risk. Adult fitness is expected to decrease slightly when area avoidance delays their upstream migration, and in the case of adult sDPS green sturgeon, will also cause decreased feeding opportunities. Beyond 2,154 meters, underwater sound is expected to attenuate down to effective quiet underwater sound levels, or 150 dB RMS or less, and therefore 2,154 meters from the pile being driven is considered the limit of this ecological surrogate. The behavioral surrogate will be limited in general to 2,154 meters from the boundary of the construction footprint and cofferdam placement, and exceeding 150 dBRMS beyond 2,154 meters from the construction site boundary will be considered exceeding expected incidental take levels for this surrogate.

Impact pile driving is also expected to produce underwater pressure waves that are expected to injure or kill CCV steelhead and sDPS green sturgeon within 18 meters of the pile being driven. The largest size of pile is estimated to produce a maximum of 210 dB peak sound. Risk to fishes will be present as long as impact pile driving is occurring. Beyond 18 meters, cumulative SELs are expected to injure fish that remain in the area during in-water pile driving activities. Considering that underwater sound will be controlled by working behind dewatered cofferdams/inside the gate foundations and the cumulative SELs over 187 dB will be somewhat controlled. Injuries to fish are expected to occur out to 1,597 meters from the driven pile. Beyond these distance thresholds, underwater pressure waves are expected to decrease below lethal and injurious levels. The lethal distance surrogate will be limited to an 18-meter radius from each pile driven with an impact hammer. The injurious distance surrogate will be limited 1,597 meters from the construction site boundary, and exceeding 206 dB peak or 187 dB cumulative SEL, respectively, beyond these distances will be considered exceeding expected incidental take levels for these surrogates.

2.9.1.3 Incidental take associated with barge and boat traffic noise

During the two years of construction that it will take to complete the construction of the tidal gate, barges and boats would be needed to transport materials and machinery. NMFS expects these species and life stages to be present during the construction in-water work window from mid-July to mid-October for 2020-2021 seasons and to November 1 for 2019 season only:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

Quantification of the number of fish exposed to the underwater noise from barge and boat traffic is not currently possible with available monitoring data. All fish passing through or otherwise present during construction activities will be exposed to construction noise. NMFS assumes that the Corps will adhere to the project description provided for the purposes of the section 7 consultation, and will not depart from that description in any meaningful or demonstrable way. Elevated noise disturbance is expected to elevate fish stress levels even when no observable behavior changes are made, and are expected to decrease individual’s overall fitness and survival through compounding sub-lethal effects. The most appropriate threshold for incidental take consisting of fish displacement, behavior modification, with elevated underwater noise is an ecological surrogate of the amount of habitat affected by elevated underwater noise within a certain distance from the construction site. Observations of erratically behaving fish within 500 feet of construction activity in adjacent waterways during any 24 hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2.9.1.4. Incidental take associated with dewatering and fish relocation

NMFS expects that during the dewatering activities of the cofferdam, there is a possibility that fish can become entrained behind the cofferdam and fish handling and relocation would be required. This would occur during the in-water work window of mid-July through mid-October. NMFS expects that these species and life stages may be present and have the potential to become entrapped behind the cofferdam:

- Adult CCV steelhead
- Adult and juvenile sDPS green sturgeon

The proposed action would include dewatering of the work area behind the cofferdam. Dewatering of this enclosed area is expected to result in take in the form of harm, injury or death to stranded fish, as well as to handling of captured and relocated fish. Because of the variability and uncertainty associated with the population sizes of the species, annual variation in the timing of migration, and variability regarding individual habitat use of the action area, the actual number of individuals that are expected to be incidentally taken per species is not known, though expected to be low during construction of the cofferdam. However, it is possible to estimate the extent of incidental take in terms of an ecological surrogate. The size of the cofferdam area and fixed wall, from the north tip of Dad's Point levee to the right bank of the San Joaquin River (800 linear feet) will serve as the surrogate for harm. During fish capture/handling/relocation process, total immediate mortality is expected to be equal to or less than 3% of the total number of all relocated fishes. If this overall mortality level or size of the cofferdam is exceeded, the proposed action will be considered to have exceeded anticipated take levels.

2.9.1.5. Incidental take associated with operations and maintenance of the flood gate

NMFS expects that during the operations of the flood gate structures, closures for water elevations greater than +8.0 feet NAVD88 will occur only during the period from November 1 through April 30. NMFS expects these species and life stages to be present during this portion of the proposed project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above would be exposed to the operations of the Smith Canal flood control structure. NMFS expects that take would be in the form of mortality and morbidity resulting from entrapment of listed fish behind the closed gate. Trapped fish would have an elevated vulnerability to predation and exposure to degraded water quality in the waterbodies upstream of the closed gate structures. Quantification of the number of individual fish exposed to predation and degraded water quality is not currently possible with available monitoring data. Gate closures would only occur for high tides or water elevations exceeding +8.0 feet NAVD88 or required maintenance. Therefore, the frequency of gate operations is defined by the water elevation and is used as a surrogate for the exposure of fish to entrapment behind the gates. Operations of the gates at water elevations below +8 feet NAVD (except for maintenance purposes) would result in more frequent operations of the flood gate structure which would result in more opportunities to entrap fish. NMFS considers this as creating conditions that have exceeded anticipated take levels, triggering the need to reinitiate consultation on the proposed project for non-maintenance reasons.

Additionally, NMFS expects that the presence of the flood gate structures would create altered flow conditions related to the narrow width of the flood control structure gates. This would enhance predation upon listed fish species. These conditions would be present throughout the year and are created by daily tidal flows. All listed species identified above would be exposed to the operations of the Smith Canal flood control structure. NMFS expects take in the form of mortality and morbidity resulting from predation of listed fish moving through the open gate or along the face of the flood structure. Listed fish would have an elevated vulnerability to predation due to the hydrodynamic conditions created by the open gate structures and the vertical sheet pile wall structure placed into the open water environment, both of which are expected to attract predators. Quantification of the number of fish exposed to predation is not currently possible with available monitoring data. The level of take is associated with the creation of a high velocity flow through the narrow gate opening, currently designed to be approximately 50 feet wide. The width of the gate is an integral factor in determining the velocity of the water flowing through the open gate, as well as the water elevation differential between the two sides of the flood structure. If the gate opening is made narrower, the velocity increases, thereby creating more adverse conditions for listed fish passing through it. Higher velocities create more turbulence, eddies, and disorientation to the fish caught in the high velocity jet, allowing them to become easier targets for predators. A wider gate opening would have the opposite effect, reducing the velocity of the flow. NMFS considers any changes to the gate opening that would make it narrower and thus increases the velocity of water moving through the open gate as exceeding anticipated incidental take as analyzed in this biological opinion. The level of take associated with placing a vertical structure in the channel (*i.e.*, the sheet pile wall) is related to the linear length of the wall, and the holding and hiding habitat that it can provide to predators residing in the area. Increasing the length of the wall would increase the potential predator holding habitat. Conversely, shortening the length of the wall would reduce the predator holding habitat. NMFS considers any changes to the length of the wall that demonstrably increases its linear length (currently designed to be approximately 800 feet for Smith Canal) would exceed the anticipated incidental take of listed fish as assessed in this biological opinion.

2.9.2. Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1) Measures shall be taken by the Corps, or its applicant, to minimize sediment events and turbidity plumes in the action area and related direct and indirect effects, as discussed in this biological opinion.

2) Measures shall be taken by the Corps, or its applicant, to reduce underwater sound impacts and other disturbances related to pile driving and barge and boat traffic, as discussed in this biological opinion.

3) Measures shall be taken by the Corps, or its applicant, to reduce mortality of listed species requiring capture/relocation in association with dewatering activities.

4) Measures shall be taken by the Corps, or its applicant, to reduce the extent of degradation and alteration to the habitats in the action area as a result of the tidal gate and riprap placement, related to both direct and indirect effects of this project, as discussed in this biological opinion.

5) Measures shall be taken by the Corps, or its applicant, to minimize impacts to existing vegetation.

6) Measures shall be taken by the Corps, or its applicant, to prepare and provide NMFS with a plan and a report describing how listed species in the action area would be protected and/or monitored and to document the observed effects of the action on listed species and critical habitat.

2.9.4. Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

    a. A qualified biologist shall use a held-hand turbidity monitor to conduct water quality monitoring during all in-water activities to ensure the turbidity control measures are functioning as intended. If an in-river turbidity plume is created and conditions within the plume exceed take limits (50 NTUs above ambient) for listed species, the Corps, or its applicant, shall coordinate with NMFS within 24 hours after an event that exceeds the given water turbidity surrogate, to discuss ways to reduce turbidity back down to acceptable levels.

b. The following BMPs shall be incorporated into the Project to reduce, minimize or avoid turbidity associated with construction activities:

   i. Implement appropriate measures, such as straw wattles and silt fencing, to prevent debris, soil, rock, or other material from entering the water from land.

   ii. Use a water truck or other appropriate measures to control dust on haul roads, construction areas, and stockpiles. Application of water would not be excessive or result in runoff into storm drains or waterways.

   iii. Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, additional erosion and sedimentation control measures would be implemented.

   iv. Maintain sediment and erosion control measures during construction. Inspect the control measures before, during, and after a rain event.

   v. Train construction workers in stormwater pollution prevention practices.

   vi. Revegetate disturbed areas with native seeds or plantings in a timely manner to control erosion.

   vii. If vegetation is not growing sufficiently it shall be replanted or provided with irrigation if necessary.

   viii. Erosion control BMPs will be monitored for effectiveness during the active construction window and during periods of inactivity following the active construction window for effectiveness, particularly during the rainy season.

2. The following terms and conditions implement reasonable and prudent measure 2:

   a. In-water and barge-mounted pile driving shall only occur during the July 15th – October 15th work window for 2020-2021 seasons and to November 1 for 2019 season only. Impact pile driving within a cofferdam surrounded by water is considered in-water pile driving.
   b. Barge and boat traffic shall not occur outside of the in-water work windows.
   c. During the seasonal in-water work window of July 15th – October 15th, at least one day per week, the project shall not include pile-driving of any kind so that CCV steelhead and sDPS green sturgeon using the habitat may migrate or forage undisturbed.
   d. During the in-water work window of July 15th – October 15th, when water temperatures are below 75°F, the daily work schedule shall be limited to between one hour after sunrise to one hour before sunset, to avoid peak fish migration times and to allow for cumulative SEL impacts to reset daily.
   e. When local water temperatures are below 75°F, the number of impact strikes per day shall be limited to 1,000 to reduce potential injuries to CV spring-run Chinook salmon, CCV steelhead and sDPS green sturgeon through cumulative SEL.

f. Piles shall be driven into place using a vibratory hammer first, and effort shall be made to gradually build up to the maximum impact force, to give fish in the area opportunity to vacate under normal swimming effort and avoid injury or death. Impact pile driving shall only be utilized after vibratory hammering was initially applied, and greater force or load testing is required for the particular pile.
g. When local water temperatures are below 75°F, attenuation measures shall be used during impact pile driving to control and dampen underwater pressure wave propagation. Effective attenuation measures include:
    i. Pile driving within a dewatered cofferdam or caisson.
    ii. Use of a bubble curtain.
    iii. Use of a cushion block.

h. Underwater sound monitoring shall be conducted during impact pile driving when water temperatures are below 75°F, to ensure incidental take limits are not exceeded according to the ecological surrogates assigned.
    i. No more than 150 dB RMS beyond 2,154 meters from the boundary of the construction footprint/cofferdam placement.
    ii. No more than 187 dB SEL cumulative beyond 1,597 meters from the construction site boundary per day.
    iii. No more than 206 dB peak beyond an 18-meter radius from each pile driven with an impact hammer.

3. The following terms and conditions implement reasonable and prudent measure 3:

    a. During dewatering activities, a qualified fish biologist shall be present onsite to make observations, and capture/relocate fish if they become entrapped in the dewatered area.

    b. Only fish biologists trained in salmonid capture and relocation shall remove and relocate fish during dewatering activities.

    c. A fish relocation plan will be submitted to NMFS for approval prior to commencing activities.

4. The following terms and conditions implement reasonable and prudent measure 4:

    a. The placement of riprap on the river bank shall be limited to the extent described in the project Biological Assessment. Voids created by the riprap boulders shall be filled by smaller diameter rocks/gravel when below the OHWM to avoid supporting piscivorous predator ambush habitat. After the first storm and snowmelt season following placement of this smaller gravel, the area shall be examined to ensure the smaller gravel was not scoured out and effectively removed. If it is found to be removed, the Corps or its applicant must develop a plan for maintenance of this BMP over time so that this adverse effect can be reduced and controlled, provide NMFS with a draft of the plan for review, and implement the plan after receiving NMFS' concurrence.

b. The Corps or the applicant shall minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.

c. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period.

5. The following terms and conditions implement reasonable and prudent measure 5:

   a. The Corps or the applicant shall ensure that the planting of native vegetation will occur as described in the Biological Assessment and within this biological opinion. All plantings must be provided with the appropriate amount of water to ensure successful establishment.

6. The following terms and conditions implement reasonable and prudent measure 6:

   a. The Corps, or its applicant, shall provide a report of project activities to NMFS by December 31 of each year construction takes place.

   b. The report shall include a summary description of in-water construction activities, incidental take avoidance and minimization measures taken, and any observed take incidents, including number and species captured and relocated during dewatering.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1) The Corps should continue supporting and promoting aquatic and riparian habitat restoration within the San Joaquin River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize adverse effects to listed species should be encouraged.

2) The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

3) The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Lower San Joaquin River Feasibility Study Project.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.11 Reinitiation of Consultation

This concludes formal consultation for the Smith Canal Gate Project.

As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the Action Agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC, 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The geographic extent of salmon freshwater EFH is described as all water bodies currently or historically occupied by PFMC managed salmon within the USGS 4th field hydrologic units identified by the fishery management plan (PFMC, 2014). This designation includes the Lower San Joaquin River (HUC 18040002) for all runs of Chinook salmon that historically and currently use these watersheds (spring-run, fall-run, and late fall-run). The Pacific Coast salmon fishery management plan also identifies Habitat Areas of Particular Concern (HAPCs): complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation, of which, the HAPC for complex channel and floodplain habitat is expected to be either directly or indirectly adversely affected by the proposed action. Because of the extensive urbanization that has occurred in the California Central Valley over the last 100 years, the San Joaquin River in the action area has been leveed and channelized and is currently degraded habitat for complex channel and floodplain HAPC.

3.2 Adverse Effects on Essential Fish Habitat

Effects to the HAPC for complex channel and floodplain habitat are discussed in the context of effects to critical habitat PBFs as designated under the ESA and described in section 2.5.2. A list of adverse effects to this EFH HAPC is included in this EFH consultation, which are expected to be similar to the impacts affecting critical habitat, including: sediment and turbidity, in-channel disturbance from pile driving, and permanent habitat loss/modification.

Sediment and turbidity

- Degraded water quality
- Reduction/change in aquatic macroinvertebrate production
- Increased scouring

In-channel disturbance from pile driving
- Channel disturbance and noise pollution from pile driving activity and associated piles

Permanent habitat loss/modification
- Permanent habitat loss due to placement of riprap
- Reduced shelter from predators
- Reduction/change in aquatic macroinvertebrate production
- Reduced habitat complexity
- Reduced water quality (flow and contaminants) due to the operations of the tidal gate
- Permanent loss of habitat due to placement of tidal gate

3.3 Essential Fish Habitat Conservation Recommendations

The following are EFH conservation recommendations for the proposed project:

To address the adverse effects of sediment and turbidity:
Implement BO Section 2.9.4 Terms and Condition 1.

To address the adverse effects of in-channel disturbance from pile driving:
Implement BO Section 2.9.4 Terms and Condition 2.

To address the adverse effects of permanent habitat loss/modification:
Implement BO Section 2.9.4 Terms and Condition 4 and 5.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 1.65 acres of designated EFH for Pacific Coast salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the Action Agency. Therefore, we ask that in your statutory reply to the

EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include the SJAFCA and the Central Valley Flood Protection Board. Individual copies of this opinion were provided to the Corps. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, ‘Security of Automated Information Resources,’ Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this biological opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

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UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCRO-2023-00269

May 18, 2023

Matt Hirkala
Project Manager
California Delta Section
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Smith Canal Gate Project, second re-initiation

Dear Mr. Hirkala:

Thank you for your letter of March 13, 2023, requesting a second re-initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the Lower San Joaquin River Feasibility Study Smith Canal Gate Project. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR Part 402, as amended; 84 Fed. Reg. 44976, 45016 (August 27, 2019)).

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA, 16 U.S.C. 1855(b)) for this action. Enclosed we provide NMFS's review of the potential effects of the proposed action on EFH for Pacific Coast Salmon in the project section, as designated under the MSA. The document concludes that the project will adversely affect the EFH of Pacific Coast Salmon in the action area and includes EFH Conservation Recommendations.

As required by section 305(b)(4)(B) of the MSA, the U.S. Army Corps of Engineers (Corps) must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS EFH Conservation Recommendations unless NMFS and the Corps have agreed to use alternative time frames for the Corps' response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Corps must explain its reasons for not following the Recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)). In your response to the EFH portion of this consultation, we ask that you clearly identify the number of Conservation Recommendations accepted.

Based on the best available scientific and commercial information, the biological opinion concludes that the proposed project is not likely to jeopardize the continued existence of the federally listed threatened Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), threatened California Central Valley steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened southern DPS of North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

Please contact Monica Gutierrez at (916) 930-3657, or via email at Monica.Gutierrez@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator
California Central Valley Office

Enclosure

cc: Copy to File: 151422-WCR2023-SA00011

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Endangered Species Act (ESA) Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Lower San Joaquin River Feasibility Study – Smith Canal Gate

NMFS Consultation Number: WCRO-2023-00269

Action Agency: U.S Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Central Valley spring-run Chinook Salmon ESU (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	N/A (Does not occur within the action area for this species)	N/A (Does not occur within the action area for this species)
California Central Valley steelhead Distinct Population Segment (DPS (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern DPS of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By: A. Catherine Marcinkevage
Cathy Marcinkevage
Assistant Regional Administrator for California Central Valley Office

Date: May 18, 2023

TABLE OF CONTENTS

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3, below.

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR Part 402, as amended.

We also completed an essential fish habitat (EFH) consultation on the proposed action, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR Part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2. Consultation History

On June 7, 2016, NMFS issued a biological opinion on the overall Lower San Joaquin River Feasibility Study (LSJRFS). NMFS concluded that the project was not likely to jeopardize the continued existence of the federally listed species and designated critical habitats. The Smith Canal Gate project is one component of the larger LSJRFS project, but a full detailed description and design for the Gate was not available at that time.

On November 6 and 7, 2018, NMFS and the U.S. Army Corps of Engineers (Corps) had discussions over the phone and via email regarding how to move forward with the Smith Canal Gate consultation, after new information was developed for the project description and Gate design.

On November 27, 2018, NMFS and the Corps had a conference call to review a draft Biological Assessment (BA) of the Smith Canal Gate project.

On April 4, 2019, NMFS received an initiation package requesting formal section 7 consultation for the Smith Canal Gate Project. Upon review of the biological assessment, NMFS provided the Corps with a list of questions that needed to be clarified in order to analyze the effects of the proposed action.

On May 9, 2019, upon review of the Corps' response email to the information requested by NMFS, NMFS initiated formal consultation.

On October 18, 2019, NMFS issued a biological opinion to the Corps, concluding the proposed action was not likely to jeopardize the continued existence of the federally listed species and not likely to destroy or adversely modify their designated critical habitats.

On October 13, 2020, the San Joaquin Area Flood Control Authority (SJAFCA) received technical assistance from NMFS via email to extend the Year 1 in-water work window from July 15 to November 15, 2020, to accommodate installation of all sixty-four foundation piles (2020 season). Based on the information received from SJAFCA, the proposed project related activities from pile driving (behind a cofferdam) and barge/boat traffic would remain unchanged from NMFS' 2019 biological opinion, therefore re-initiation was not warranted. In-water work was completed on November 9 and all equipment used for in-water work was demobilized on November 10, 2020, thereby completing all Year 1 in-water work activities within the extended in-water work window.

On February 5, 2021, the Corps had a call with NMFS to review additional potential modifications of the in-water construction activities for Year 2.

On February 26, 2021, the Corps requested re-initiation of formal consultation of Smith Canal Gate project, as a result of the changes to the proposed action described below in section 1.3.1, and consultation was initiated on this date.

On April 30, 2021, NMFS issued an updated biological opinion to the Corps, concluding the proposed action was not likely to jeopardize the continued existence of the federally listed species and not likely to destroy or adversely modify their designated critical habitats.

On October 14, 2022, the Corps, SJAFCA and their attorneys and consultants (KSN, Inc., and ECORP Consulting) requested an extension of the in-water work window after October 15, 2022, in order to continue work on the project. NMFS denied the request and informed the Corps and SJAFCA that re-initiation of consultation would be necessary.

On December 23, 2022, NMFS reviewed and provided comments on a draft BA from SJFCA's consultants, KSN Inc., and ECORP Consulting, Inc.

On January 4, 2023, NMFS reviewed the revised BA from SJFCA's consultants, ECORP Consulting, Inc.

On March 1, 2023, representatives from NMFS, SJFCA, KSN Inc., and ECORP Consulting, Inc., conducted a site visit to Smith Canal to discuss and review the current status of the project.

On March 7, 2023, NMFS, Corps, SJFCA, and ECORP, Consulting, Inc. discussed the project scope and agreed to additional minimization measures for the project.

On March 13, 2023, the Corps requested the second re-initiation of formal consultation of Smith Canal Gate project, as a result of the changes to the proposed action described below in section 1.3.1, and consultation was initiated on this date.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019

Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR 402.02). We considered, under the ESA, whether or not the proposed action would cause any other activities and determined that it would not. Under the MSA, Federal action means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

The Corps is the lead Federal agency for authorizing this action, known as the Lower San Joaquin River Feasibility Study (LSJRFS), a component of which includes the Smith Canal Gate Project (Project), pursuant to section 404 of the Clean Water Act of 1972, as amended and Section 10 of the Rivers and Harbors Appropriation Act of 1899. The Central Valley Flood Protection Board and SJAFCA are the non-Federal project sponsors partnering with the Corps on the Project. SJAFCA is requesting authorization to complete the Smith Canal Gate portion of the Project located in the San Joaquin River, City of Stockton, San Joaquin County, California (Figure 1).

The proposed action would implement flood risk-reduction measures in the vicinity of the Smith Canal and the San Joaquin River in, and adjacent to, the City of Stockton. The proposed action would consist primarily of completing a partially constructed fixed flood wall filled with granular material that would extend approximately 800 feet from the north tip of Dad's Point to the east bank of the San Joaquin River at the Stockton Golf and Country Club. The fixed floodwall features a recently constructed 50-foot-wide gate that can be closed when high flow events are forecasted to approach or exceed design operating water surface elevations (8.0 feet NAVD88). During high flow and/or high tide events, the gate structure would isolate Smith Canal from the San Joaquin River and allow existing levees to function as a secondary flood risk-reduction measure. The gate would be closed only as needed for flood control to prevent flood flows from entering Smith Canal, and would otherwise remain open to allow for recreation, navigation, and tidal movement in and out of Smith Canal.

Construction of the project, as originally proposed, was anticipated to require two years of in-water construction; however, additional assessments made by the Project team in 2019 (during the pre-project Test Pile Program [TPP]) determined that the project would likely require three years of in-water work to complete (i.e., 2020, 2021, and 2022). Contractor progress at the completion of Year 3 (2022) in-water work has demonstrated that up to four additional in-water work seasons (2023 through 2026) may be required to complete the project (including two partially overlapping seasons for the warranty inspection (2024-2025) and warranty repair period (2025-2026). Information gathered from project construction to date indicates pile driving for each fixed floodwall cell takes approximately 2-3 weeks to complete. Five north wall and eleven south wall cells remain to be completed. Assuming a best-case scenario of two weeks for each wall cell, flat sheet pile driving alone will take 32 weeks (eight months). Assuming a worst-case scenario of three weeks for each wall cell, flat sheet pile driving will take up to 48 weeks (11 months).

Five additional north floodwall cells and 11 south floodwalls cells would be installed to complete construction of the approximately 800 linear foot long sheet pile flood wall. Additional infrastructure would include placement of fill materials, installation of protection piles, dredging for installation of fill materials (rock slope protection (RSP)/rip rap) around the gate structure and installation of fender piles near the gate foundation corners.

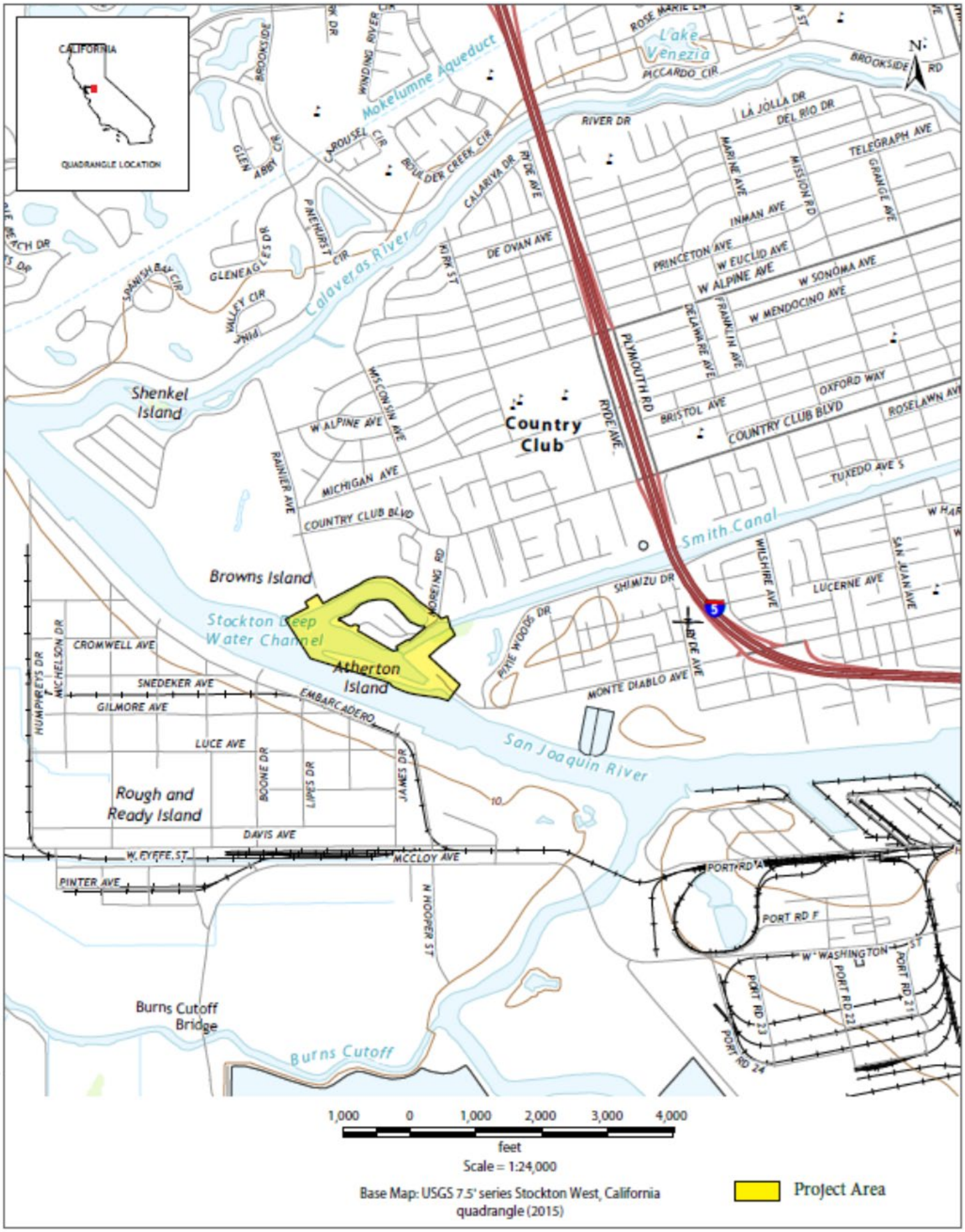

Figure 1. Proposed project area.

Construction Materials

Two staging areas would be used for the project: at the Louis Park parking area near the boat launch at the base of Dad's Point, and a second located approximately one mile up the San Joaquin River. Construction materials to be used are 85-foot long steel flat sheet piles for the fixed cellular wall, 36" diameter steel pipes for the protection and fender piles and, riprap boulders for scour protection. Other materials imported to the site could include incidental construction support materials, aggregate base rock, asphalt, concrete, and hydroseed. Materials would be brought to the project site via truck or barge, depending on the location of the staging area, the size, or amount of the material being brought to the site. Barges or boats will be used to deliver materials and equipment via the San Joaquin River and the Stockton Deep Water Ship Channel (DWSC).

Debris from dredging, clearing, and grubbing between the connection of the gate structure and the shoreline would be hauled to one of two permitted disposal sites: the Lovelace Materials Recovery Facility in Manteca, California, approximately 12.5 miles from the project site, or the North County Recycling Center and Sanitary Landfill in Lodi, California, approximately 22 miles from the project site. Alternatively, dredged material could be disposed of at an upland site with no connectivity to waters of the United States. Any upland disposal site selected would be closer to the project site than the two facilities described above.

Operation of Watercraft

Boats (less than 30 feet long) will ferry labor and small equipment to the project area during all months of the year. Travel distances are anticipated to be between 0.3 and 1.2 nautical miles. These trips will facilitate access from staging areas to the uncompleted cells on the north and south floodwalls. SJAFCA also proposes to continue to use small boats to perform biological and environmental monitoring during all months of the year.

The Project will use floating barges/platforms to stage cranes, pile drivers, and materials. Cranes operating from platform decks move and place gate materials into the ring cofferdam in all months of the year. Platforms have no propulsion systems and generate no noise. Tugboats will move barges/platforms into position for cranes to accomplish various construction activities.

Cofferdam Removal

The temporary metal sheet pile cofferdam that was installed for construction and installation of the gate structure is anticipated to be deconstructed and removed in Year 4 (2023). The contractor will mobilize to the cofferdam site with a crane and material barge that will be placed into position by a tugboat. Once in position, a vibratory hammer suspended from the crane will be used for the cofferdam sheet pile extraction process. The sheets would be removed in pairs. There are approximately 68 pairs of sheet piles forming the cofferdam. SJAFCA anticipates two material barge trips are needed to transport the sheet piles to the lay down yard where they will be offloaded from the material barge by a land-based crane and stored. The cofferdam removal process is anticipated to take approximately two weeks to complete.

Gate Structure - RSP Installation, Warranty Testing, and Repairs

The area around the gate structure will be dredged to facilitate installation of rock slope protection (RSP). RSP would be placed around the gate structure foundation to provide scour protection. SJAFCA proposes to place 0.386-acre (1,200 tons) of 18-inch minus RSP material around the gate foundation (Gate RSP) to prevent scour of the gate foundation over time. Interstitial spaces in the Gate RSP will be filled with 6-inch minus rock to avoid creating potential fish predator habitat (i.e., predator refugia) in the RSP voids. Most Gate RSP (0.363 acre or 15,811 ft^2) will be placed 1 to 10 feet below the existing bottom elevation of Smith Canal/Atherton Cove as a blanket of one to two feet thick (deep RSP). The outer-most periphery of the Gate RSP blanket (0.023 acre or 1,002 ft^2) will be placed at or above existing bottom elevation (surficial RSP). SJAFCA expects the deep RSP area will backfill to the pre-activity bottom elevation with native sediments due to tidal exchange and river flows. RSP placement will be isolated from San Joaquin River and Atherton Cove by installation of a turbidity curtain to comply with turbidity limits in Project permits (i.e., no more than 50 NTUs above background).

RSP will also be placed where the south and north floodwalls meet land at Dad's Point and the Stockton Golf Course, respectively. The same methods provided above for Gate RSP will be used for installation of RSP at these terminal wall locations. RSP placement at Dad's Point and the golf course was analyzed in a previous NMFS consultation.

The completed gate would be tested and put into service before the northern side of the fixed wall is completed to ensure recreational boat access between Atherton Cove and the San Joaquin River. Following the completion of Project construction, SJAFCA will inspect the operable and fixed elements of the gate and wall structure for damage and/or deficiencies and, if necessary, conduct minor repairs. Above-water inspections would be performed by personnel from vantage points at the top of the floodwalls (north and south), from small watercraft, and from catwalks above the gate leaves/doors. Subsurface inspections may also be performed by divers or by using remotely operated vehicles (ROVs) fitted with video equipment. Deficiencies identified during the warranty testing period would be remedied during the in-water work windows. Warranty repair work would likely (depending on the nature of work required) require gate dewatering and rewatering, and repairs made to necessary facilities. Subsurface repairs would be implemented by divers or by ROVs. Repairs anticipated would include seal replacements, fastener replacements, bearing repairs or replacements, coating repairs above the waterline, and adjustments to the gate hinges by divers or ROVs.

Fixed Wall Construction - Remaining Installation

Fixed wall construction will consist of (a) continued installation of the southern cellular sheet pile wall structure consisting of 11 cells (cells A, B, and R through Z) between Dad's Point and the existing gate structure ring cofferdam and (b) installation of five cells (cells DD through HH) along the northern cellular sheet pile wall structure. The fixed wall consists of two cellular steel sheet pile walls that would be driven into the riverbed by vibratory or impact hammer. The floodwall cells are 29 feet wide at the connection between cells and 34 feet wide at the widest part of each cell. The floodwall would have a top elevation of 15.0 feet (NAVD88), extending 10 feet above the mean water level at the entrance to Smith Canal. Granular material would be installed between the walls using a front-end loader operating from the previously completed cells of the wall. The granular material would consist of a sand and gravel mixture. The contractor intends to install flat sheets used to form the cellular floodwall using only vibratory pile-driving methods when site conditions are favorable. An impact hammer will be used on the cellular floodwall sheet piles when vibratory methods are ineffective.

The north end of the fixed wall would be integrated into the existing FEMA-accredited levee near the Stockton Golf and Country Club. This integration would be designed so that it would not affect the integrity of the existing levee system. Sheet pile wing walls would be driven along the levee perpendicular to the north end of the fixed wall, and the wing walls would be tied into the end of the fixed walls using interlocking sheet piles. Interlocking sheet piles would also be used at the Dad’s Point tie-in, connecting the southern-most cell of the fixed wall to two parallel sheet pile walls driven into the end of Dad’s Point.

Upon completion of construction, a locked security gate would be installed at the south end of the fixed wall on Dad’s Point and at the north end of the fixed wall at the Stockton Golf and Country Club. The gate would be eight feet high and prevent public access to the fixed wall and gate structure. Access to the gate structure through the security gate would be limited to SJAFCA and authorized maintenance representatives.

Once construction of the fixed wall is complete, thirty-six 36” steel pipe pile dolphins would be installed on the San Joaquin River side of the wall to protect it from boats colliding into the wall, and four 36-inch diameter fender piles would be installed near each corner of the gate foundation, on both the San Joaquin River and Smith Canal sides of the gate structure. The pipe piles would be driven using a barge-mounted impact hammer or vibratory hammer. The dolphin piles would be spaced every 16 feet on each side of the gate structure and would be placed approximately 55 feet away from the centerline of the fixed wall. The fender piles would have a floating fender that would move up and down the pile with the tide, and all four fender piles would have a solar-powered light-emitting diode navigation light mounted on top.

Planter boxes would also be installed along the top edge of the Atherton Cove and Smith Canal side of the fixed wall. The planter boxes would be designed to allow vegetation to hang down over the top half of the wall, but would not extend below the water surface. Construction of the fixed wall would be staggered over two years in order to comply with the in-water work period from July 1 to November 30 in 2023 and 2024. The remaining southern and northern portions of the fixed wall would be installed during the third and fourth years of construction. The northern floodwall would not be completed until the gate structure has been tested to confirm operability, the miter gate leaves are opened, and the cofferdam is removed.

Work to construct the remaining fixed wall would be done using barge-mounted or land-based equipment. The granular material would be delivered to the construction site by a truck or barge using a crane equipped with a clamshell bucket.

Riprap Placement

Once the fixed wall is constructed, approximately 3,400 tons of riprap (approximately 200 linear feet) would be placed along the banks at the Stockton Golf and Country Club (approximately

100 linear feet on each side of the fixed wall). Additionally, 230 linear feet around the tip of Dad's Point headlands. Riprap ≥ 18 inches would be of a gradation of sizes to minimize large voids. The wall tie-ins are designed to be stable, but the riprap would be needed for scour protection during flood events. The riprap would be placed using either an excavator or a clamshell bucket.

Completion of Cone Penetration Tests

Approximately 13 Cone Penetration Tests (CPTs) (twelve in-water and one on land) near the floodwall and seepage cutoff wall alignments (on Dad's Point) will be completed to better characterize the geological composition of the Project area and to satisfy Corps' requirements. The proposed 13 CPTs will supplement the 5 CPTs previously conducted in October, 2019 and authorized under NMFS' October 18, 2019 biological opinion. Completed CPTs will be used to further inform the design depths for floodwall flat sheet piles, protective pipe piles, and levee embankment and seepage analyses at Dad's Point. No impact or vibratory hammer is used to advance the sleeve or sensor. Rather, it is hydraulically pushed at a consistent rate of approximately 1-inch per second to the target depth. The CPT sensor is then removed, and a concrete grout plug is injected into the sleeve to seal the created void. The sleeve is withdrawn, leaving the concrete plug deeply (generally, no shallower than 10 feet below bottom elevation) embedded in the bottom sediment profile. The top of the concrete plug will not contact the waters of the San Joaquin River or Atherton Cove.

Construction Timing

SJAFCA originally anticipated that construction of the project would last approximately two years. This timeline was evaluated in the October 18, 2019, biological opinion. SJAFCA then requested two additional years to finish project construction which was evaluated in the April 30, 2021, biological opinion. Many aspects of the project were completed between 2019-2022, however numerous aspects remain uncompleted and are the subject of this fourth biological opinion. This biological opinion addresses the remaining components for Year 4 (2023), Year 5 (2024), Year 6 (2025) and Year 7 (2026).

There are three primary periods for construction and evaluation of the Project, listed below:

1) In-water work for Year 4 (2023) and Year 5 (2025). In-water work will occur from July 1 through November 30 with the following timing conditions:
    a. Flat sheet piles could be impacted from July 15 to November 30, a maximum of 5,000 impacts per day, regardless of local water temperatures;
    b. Pipe piles (aka dolphins and fenders) could be impact driven from July 15 through October 15, a maximum of 5,000 impacts per day, regardless of local water temperatures; and
    c. Vibratory driving of flat sheet piles and/or pipe piles will occur from July 1 to November 30, regardless of local temperatures;
    d. Under no circumstances would more than 5000 impact strikes occur per workday, with any combination of pile types installed.
2) In-water work for warranty testing and repairs in Year 5 (2024), Year 6 (2025), and Year 7 (2026). Warranty testing of the gate structure would occur during Year 5 (2024) from

July 1 to November 30. Warranty testing in Year 6 (2025) would occur from July 15 to October 15th. Warranty repairs would occur, if necessary, in Year 6 (2025) and Year 7 (2026) between July 15 to October 15.

3) Project-related boating and barging would occur year-round from Year 4 (2023) through Year 7 (2026), as needed.

Construction of the Project, as described in the third biological opinion (April 30, 2021), was anticipated to require two additional years of construction; however, following subsequent assessments in 2022, SJAFCA determined that the Project would likely require four additional years to complete. The critical elements for completion of Project construction in Year 4 (2023) and Year 5 (2024) are finishing construction of the southern wall extending from the gate structure to Dad's Point, and finishing the northern wall to the golf course. These sections of the wall, which will be constructed in-water, are anticipated to take approximately five months in Year 4 (2023) and five months in Year 5 (2024). To facilitate this schedule, the in-water work window would be extended from July 1 to November 30th.

Year 4 (2023) and 5 (2024) will include (a) continued installation of the southern cellular sheet pile wall structure consisting of 11 cells (cells A, B, and R through Z) between Dad's Point and the existing gate structure and (b) continued installation of the northern cellular sheet pile wall structure consisting of five cells (cells DD through HH).

Two seasons of gate warranty testing would be performed during the in-water work windows of Years 5 (2024) and Year 6 (2025) following completion of Project construction, and two seasons of warranty repairs would be performed during the in-water work seasons of the years following gate testing (Years 6 and 7 [2025 and 2026]). Following the completion of Project construction, SJAFCA will inspect the gate for damage and/or deficiencies and, if necessary, conduct minor repairs. All activities associated with the inspections and repairs will be limited to the gate structure and Project facilities.

Summary of the Vibratory and Impact Pile Driving Activities

Vibratory and impact pile driving methods will be used for the construction of the remaining cells and installation of dolphins and fenders. For all sheet pile and pipe pile driving, piles would be driven to the maximum depth possible using a vibratory hammer prior to using an impact hammer. It is anticipated that all sheet piles can be driven to target depths using only vibratory methods. However, based on existing site conditions and experience gathered by SJAFCA during project construction in Year 2 (2021) and Year 3 (2022), it is likely that impact hammering will be needed to reach required depths due to existing geotechnical conditions along the wall alignment.

Construction of the dolphins will require the use of both vibratory and likely impact pile driving Steel pipe piles and sheet piles will be placed into the river channel first via vibratory pile driving, and then via impact pile driving for final setting and then load testing during the in-water work window of July 15 to October 15. Most in-water pile driving will be accomplished with a barge-mounted crane. When construction is complete, vibratory methods will be used to remove all temporary support piles and cofferdam sheet piles. For the sides of the cofferdam on the inlet/outlet sides of the gate, a diver will cut the sheet piles to the level of the gate structure floor and the sheets will be removed using a crane. The contractor will excavate and remove the portion of the pipe that is within Dad's Point after installing a concrete plug on the Smith Canal side. A summary of pile driving activities is summarized in Table 1.

Table 1. Summary of pile driving activities, per year, in Year 4 (2023) and Year 5 (2024). The five month vibratory pile driving period encompasses the three month impact period

Structure	Number of Piles	Pile Description	Type of Pile Driving	Environment	Estimated Duration
Dolphins and fenders	40	36-inch diameter steel pipe piles	Vibratory and impact	In water	5 month (vibratory) 3 month (impact)
Fixed cellular sheet pile wall New installation	≈215 sheets	AS-500-12.7 sheet piles	Vibratory and impact	In water	5 month (vibratory) 4.5 month (impact)
Fixed cellular sheet pile wall Finished/reset	≈ 563 sheets	AS-500-12.7 sheet piles	Vibratory and impact	In water	5 month (vibratory) 4.5 month (impact)

The impact pile driving assumptions for the Proposed Action allow for up to 5,000 strikes per day from July 15 through October 15 for the 36" pipe piles, and up to 5,000 strikes per day from July 15 through November 30 for flat sheet piles. Impact driving may be used for installation of the flat sheet piles and pipe piles once they have been vibrated to the maximum depth possible. The analysis assumes that various combinations of pipe piles and sheet piles could be driven on the same day with the same pile driver any given pile or combination of piles between July 15 and October 15. Under no circumstances would more than 5000 impact strikes occur in one workday, regardless of the type(s) of pile(s) driven.

Long-Term Operation and Maintenance

Once complete, the gate structure would be tested during times when boat traffic is expected to be light. During this testing, the gate would be closed and then reopened. Once the gate structure is fully operational, the gate will normally remain open to allow for tidal movement, navigation, and recreation. It would be closed as needed for flood control purposes, testing, inspection, and maintenance. For flood control purposes, the gate would be closed only during high flow and high tide events forecasted to exceed the design operating water surface elevation (8.0 feet NAVD 88); events that typically occur between November and April. The gate would be operated as needed during these times to prevent high tides from entering Smith Canal. If a high tide event is anticipated, the gate would be closed at the lowest tide prior to the forecasted high tide. The gate would remain closed until the water level in the San Joaquin River drops down to the water level in Smith Canal, at which point the gate would open. Currently, an urban area of approximately 3,430 acres drains into Smith Canal via nine storm drain pump stations. In the event that rainfall occurs while the gate is closed and causes the water level in Smith Canal to be higher than the Delta, the pump stations that pump into Smith Canal from the surrounding developed areas would be shut off until the gate is opened.

Table 2. Number of gate hypothetical closures that would have occurred between 1983 and 2013 based on stage data from the Burns Cutoff Gage Station. The number of closures over this 30-year period would have ranged from 0 to 19 times per year, with no closures occurring in 23 of those years.

Table 2. Number of days with stage greater than 8 feet NAVD88.

Year	No. Days with Stage ≥ 8.0 Feet NAVD88	Year	No. Days with Stage ≥ 8.0 Feet NAVD88
1983	19	1998	13
1984	2	1999	0
1985	0	2000	0
1986	4	2001	0
1987	0	2002	0
1988	0	2003	0
1989	0	2004	0
1990	0	2005	0
1991	0	2006	8
1992	0	2007	0
1993	0	2008	0
1994	0	2009	0
1995	0	2010	0
1996	0	2011	1
1997	12	2013	0

Based on the information presented in Table 2, it is assumed that there would be two closures per year on average for flood control purposes. This is a conservative estimate based on historical days that were above 8 feet NAVD88. In general, the gate would not need to be closed at a precise point in the tidal cycle. However, if a significant local rain event was predicted to occur at the same time as flood stage on the San Joaquin River near Stockton, timing of gate closure would need to be more precise to maximize storage space for local runoff behind the fixed wall. To be prepared for such an event, SJAFCA would develop a gate operation plan. The plan would include procedures for predicting when river stage would be high and when local rain events might be significant. For example, each year prior to November 1, SJAFCA would obtain tide prediction tables to determine the timing of peak tides. These high tides would be used to develop an "alert" table to help plan activities during the winter months. In addition, because rainfall and runoff affect water surface elevation, daily stage predictions generated by DWR would be monitored. This information would help determine when the gate would be closed for flood control purposes. The gate operation plan would consider that gate closure should occur earlier (at low tide potentially days before the flood flows are expected to arrive) if new storms were predicted for the region. The operation plan would consider scenarios of combined high stage on the San Joaquin River and significant local stormwater runoff.

Routine inspection and maintenance of the gate structure and associated equipment would be conducted on an annual basis to ensure that flood risk-reduction would be provided by the operation of the gate structure. This inspection and maintenance would be conducted on the gate's abutment seals, motors, hinges, and panels. Maintenance of the fixed wall structure corrosion protection system would take place every two years. The fill material in the fixed wall would be inspected annually, and additional fill material would be added as required.

Floating debris that has accumulated behind the fixed wall would be regularly removed. The frequency of debris removal would depend on the rate of accumulation, to be determined by regular visual monitoring of the site and collection of information from adjacent residents. Based on the information gathered, SJAFCA would schedule and implement a regular debris removal program, removing debris from the project site as frequently as needed to comply with the Water Quality Control Plan for the Sacramento River and San Joaquin River Basins' direction that "[w]ater shall not contain floating material in amounts that cause nuisance or adversely affect beneficial uses."

Water hyacinth (*Eichhornia crassipes*) also would be regularly removed from the areas on the Atherton Cove and Smith Canal side of the fixed wall through development and implementation of a water hyacinth control program to ensure that the cover of water hyacinth in the project area does not increase beyond existing conditions. The frequency of water hyacinth removal would depend on the rate of vegetation growth and accumulation, to be determined by regular visual monitoring of the site. Based on the information gathered, SJAFCA would schedule and implement a regular removal program, removing hyacinth from the project site during the growing season, which is generally from March to early December. During the growing season, mechanical harvesting would be conducted using an aquatic weed harvester whenever cover of water hyacinth reaches 20 percent in the most affected areas behind the fixed wall. The percent cover would be visually estimated from the shoreline.

Conservation Measures

SJAFCA will implement conservation and water quality measures as described in the April 30, 2021, NMFS biological opinion. These are also described in Appendix A. In addition to the Appendix A conservation measures, SJAFCA will also implement the following conservation measures in order to specifically minimize impacts associated with the extended in-water work window, incremental increase in boat and barge operation outside the construction window, removal of the 1,000 impact strikes per day condition, implementation of the CPTs, placement of the gate RSP, and implementation of the gate warranty period testing and repair:

- A California Department of Fish and Wildlife (CDFW)-approved fisheries biologist with stop-work authority will be on-site during all barge movements to monitor for erratically behaving fish within 500 feet of the tugboat; if any erratically behaving fish are observed, the biologist will temporarily halt the barge movement and contact NMFS to identify the appropriate corrective actions (e.g., reduce the tugboat motor's revolutions per minute (RPMs), monitor underwater noise levels to ensure RMS values do not exceed 150 dB RMS beyond 100 m of the tugboat).
- All Project boats (including tugboats) will obey the posted speed limit of 5 mph (4.3 knots) within Smith Canal.

- All Project boats (including tugboats) will avoid rapid acceleration within the Action Area.
- All Project boat motors (including tugboats) will be turned off when not in use;
- Movement all Project boats (including tugboats) will be restricted to the minimum amount necessary to complete the intended work;
- All pile-driving activities will be monitored by a qualified fisheries biologist to ensure that no ESA-listed fish present in the Action Area and exhibiting signs of distress;
- The contractor will implement a "soft start" method (i.e., initially driving the pile with low hammer energy and increasing hammer energy as necessary) at the beginning of each pile-driving day or after extended periods of inactivity to allow fish to leave the work area before underwater noise levels associated with impact strikes reach their full force;
- The contractor will deploy a bubble curtain around all piles being driven with an impact hammer after September 15 to further minimize sound exposure levels (SEL) values, cumulative (cSEL) values, and the frequency with which the "effective quiet" value of 150 dB SEL is exceeded;
- Impact pile driving will be limited to flat sheet piles from July 1-July 14 and during October 16-November 30 (i.e., no pipe piles will be driven with an impact hammer during this period).
- Impact pile driving after October 15 will be limited to the period between two hours after sunrise and two hours before sunset.
- Underwater noise levels will be monitored during all impact and vibratory pile driving for all pile types during the periods July 1-14 and October 16-November 30 to ensure compliance with the underwater noise ecological surrogates for peak, RMS, and, for impact driving, cSEL levels;
- During the period of October 16-November 30, the distance to compliance for the underwater noise ecological take surrogates will be reduced to:

    – Lpeak: no more than 206 dB peak beyond a 12 m radius from the source.

    – cSEL: no than 187 dB cSEL beyond an 80 m radius from the source.

    – RMS: no more than 150 dB RMS beyond a 350 m radius from the source.

- Monitoring will be conducted during all pile driving activities by a qualified biologist with authority to stop the project if sound thresholds are exceeded. NMFS will be notified if the thresholds are exceeded and the contractor will take corrective action to comply with the thresholds before reinitiating pile driving activities.
- NMFS will be notified, via email, each time a switch is made from vibratory to impact hammer after October 15 through November 30, so that NMFS can conduct a site visit.
- A fisheries biologist with work-stop authority will be present during the placement of Gate RSP and will halt construction if ESA-listed fishes are observed within or near the work area.
- A turbidity curtain will be deployed around the active work area during the placement of Gate RSP to minimize turbidity increases in the vicinity of the work area.
- A fisheries biologist will monitor all in-water work associated with CPT drillings, including backfilling of the CPT bore holes, to ensure that no ESA-listed fish are injured

or killed and to monitor water quality to ensure compliance with the turbidity and pH thresholds required in all Project-related permits and authorizations.
- Water-based CPT locations will be isolated from the San Joaquin River and Smith Canal/Atherton Cove using turbidity curtains, and water turbidity monitored, to ensure no exceedance of water quality standards per existing project permit limits.
- All dewatering during gate warranty period testing will be performed under the supervision and guidance of a qualified fisheries biologist.
- Water quality will be monitored by a qualified fisheries biologist during all in-water work activities, including during the extended in-water work window, cone penetration testing, and Gate RSP placement in accordance with the 2019 and revised 2021 BO and 401 WQC.

Habitat Mitigation

The permanent placement of 0.386-acre of RSP around the gate foundation will occur within CCV steelhead and southern Distinct Population Segment (sDPS) green sturgeon designated critical habitat. To partially offset the impact to critical habitat SJAFCA will purchase salmonid credits at a 3:1 ratio (mitigation:impact) from a NMFS approved conservation bank. For the permanent occupation of 0.386-acres of tidal perennial habitat, SJAFCA will purchase 1.16 credits. This purchase will be in addition to compensatory mitigation previously purchased by SJAFCA to satisfy compensatory mitigation agreements from previously completed NMFS consultations.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provide an opinion stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an incidental take statement (ITS) that specifies the impact of any incidental taking and includes reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1. Analytical Approach

This biological opinion includes both a jeopardy analysis and an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "jeopardize the continued existence of" a listed species, which is "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This biological opinion relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition does not change the scope of our analysis and in this biological opinion, we use the terms "effects" and "consequences" interchangeably.

We use the following approach to determine whether a proposed action is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Evaluate the range wide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their habitat using an exposure-response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species, or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.1.1. Conservation Banking in the Context of the ESA Environmental Baseline

Conservation (or mitigation) banks present a unique situation in terms of how they are used in the context of the *Effects Analysis* (section 2.5) and the *Environmental Baseline* (section 2.4) in ESA Section 7 consultations.

When NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a Section 7 consultation occurred at the time of bank establishment. A traditional interpretation might suggest that the overall ecological benefits of the conservation bank actions belong in the *Environmental Baseline*. Under this interpretation, where proposed actions include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double-counting. Such an interpretation does not reflect the unique circumstances that conservation banks serve. Specifically, conservation banks are established based on the expectation of future credit purchases. Conservation banks would not be created and their beneficial effects would not occur in the absence of this expectation.

For these reasons, it is appropriate to treat the beneficial effects of the bank as accruing in connection with and at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. This means that, in formal consultations on projects within the service area of a conservation bank, the beneficial effects of a conservation bank should be accounted for in the *Environmental Baseline* after a credit transaction has occurred. More specifically, the *Environmental Baseline* section should mention the bank establishment (and any consultation thereon) but, in terms of describing beneficial effects, it should discuss only the benefits attributable to credits already sold. In addition, in consultations that include credit purchases as part of the proposed action, the proportional benefits attributable to those credit purchases should be treated as effects of the action. Conversely, where a proposed action does not include credit purchases, it will not receive any direct offset associated with the bank. This approach preserves the value of the bank for its intended purposes, both for the value of the credits to the bank proponent and the conservation value of the bank to listed species and their critical habitat.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

2.2.1. Species Listing and Critical Habitat Designation History

The descriptions of the status of species and conditions of the designated critical habitats in this opinion are a synopsis of the detailed information available on NMFS' West Coast Regional website.

The following federally listed species Evolutionarily Significant Units (ESUs) or Distinct Population Segments (DPSs) and designated critical habitat occur in the action area and may be affected by the proposed action (Table 3 and 4):

Table 3. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Southern DPS of North American green sturgeon	Threatened, 71 FR 17757; April 7, 2006	According to the NMFS 5-year species status review (NMFS 2015) and the 2018 final recovery plan (NMFS 2018), some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers. Also, several habitat restoration actions have occurred in the Sacramento River Basin, and spawning was documented on the Feather River. However, the species viability continues to face a moderate risk of extinction because many threats have not been addressed, and the majority of spawning occurs in a single reach of the main stem Sacramento River. Current threats include poaching and habitat degradation. A recent method has been developed to estimate the annual spawning run and population size in the upper Sacramento River so species can be evaluated relative to recovery criteria (Mora *et al.* 2017).
Central Valley spring-run Chinook salmon ESU	Threatened, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016b), the status of the CV spring-run Chinook salmon ESU, until 2015, has improved since the 2010 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk. Monitoring data showed sharp declines in adult returns from 2014 through 2018 (CDFW 2018).
California Central Valley steelhead DPS	Threatened, 71 FR 834; January 5, 2006	According to the NMFS 5-year species status review (NMFS 2016a), the status of CCV steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was in danger of becoming endangered. Most natural-origin CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

Table 4. Description of critical habitat, Listing, and Status Summary.

Critical Habitat	Designation Date and Federal Register Notice	Status Summary
California Central Valley steelhead DPS	September 2, 2005; 70 FR 52488	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for CCV steelhead critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.
Southern DPS of North American green sturgeon	October 9, 2009; 74 FR 52300	Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Critical habitat in coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are included as critical habitat for sDPS green sturgeon. PBFs considered essential to the conservation of the species for freshwater and estuarine habitats include: food resources, substrate type or size, water flow, water quality, migration corridor; water depth, sediment quality. In addition, PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas. Although the current conditions of PBFs for sDPS green sturgeon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.2.1.1 Global Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley and aquatic habitat at large is climate change. Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen *et al.* 2000). Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006).

CV spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). CV spring-run Chinook salmon spawn in the tributaries to the Sacramento and San Joaquin Rivers, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Although CCV steelhead will experience similar effects of climate change to Chinook salmon, because they are also blocked from the majority of their historical spawning and rearing habitat, the adverse effects may be even greater in some cases. In the Central Valley, summer and fall temperatures downstream of dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). The Anderson Cottonwood Irrigation Dam (ACID) is considered the upriver extent of sDPS green sturgeon passage in the Sacramento River. The upriver extent of sDPS green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of sDPS green sturgeon, but temperatures at spawning locations lower in the river may be more affected.

In summary, observed and predicted climate change effects are generally detrimental to the species (McClure 2011, Wade *et al.* 2013), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure *et al.* 2013).

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area remains consistent with that as described in the October, 2019, and April, 2021, biological opinions and as described below.

Since the proposed action includes the purchase of mitigation credits from a conservation bank, the Action Area also includes the areas affected by mitigation banks that have service areas relevant to the project areas. These include the Fremont Landing Conservation Bank, which is a 100-acre site along the Sacramento River (Sacramento River Mile 78 through 80); the Bullock

Bend Mitigation Bank, which is a 116.15-acre site along the Sacramento River (Sacramento River Mile 80); Cosumnes Floodplain Mitigation Bank, which is a 472-acre site at the confluence of the Cosumnes and Mokelumne rivers (Mokelumne River Mile 22); and Liberty Island Conservation Bank, which is a 186-acre site located at the south end of the Yolo Bypass on Liberty Island in the Delta.

The project is located in the City of Stockton and unincorporated San Joaquin County, California. The project area includes Atherton Island, Atherton Cove, Louis Park (including Dad’s Point), the Stockton Golf and Country Club, and the portions of the San Joaquin River in the immediate vicinity. The area north of Smith Canal, Atherton Island, Atherton Cove and Stockton Golf and Country Club, is located in unincorporated San Joaquin County. Louis Park, including Dad’s Point, is in the City of Stockton.

Atherton Island is at the west end of Smith Canal, and Louis Park is southeast of Atherton Island at the mouth of the Canal. Dad’s Point, a land bar that is an extension of Louis Park, is southwest of the mouth of Smith Canal and separates the Louis Park boat launch area from the San Joaquin River (Figure 2). Atherton Cove is a dead-end slough of the river that extends north and east around Atherton Island, and the Stockton Golf and Country Club is along the north bank of the river and southwest shore of Atherton Cove, to the northwest of Smith Canal.

The action area includes waters of the San Joaquin River that are within 1,000 feet upstream and downstream of proposed in-water construction areas. This area represents the potential area of impacts from the proposed project, in addition to noise effects based on pile-driving noise during similar construction activities (Figure 2). CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon have the potential to occur in the action area during the proposed action’s period of construction and long-term operations. Designated critical habitats occur in the action area for CCV steelhead and the sDPS of North American green sturgeon. CV spring-run Chinook salmon critical habitat does not occur in the action area and will not be discussed further in this biological opinion.

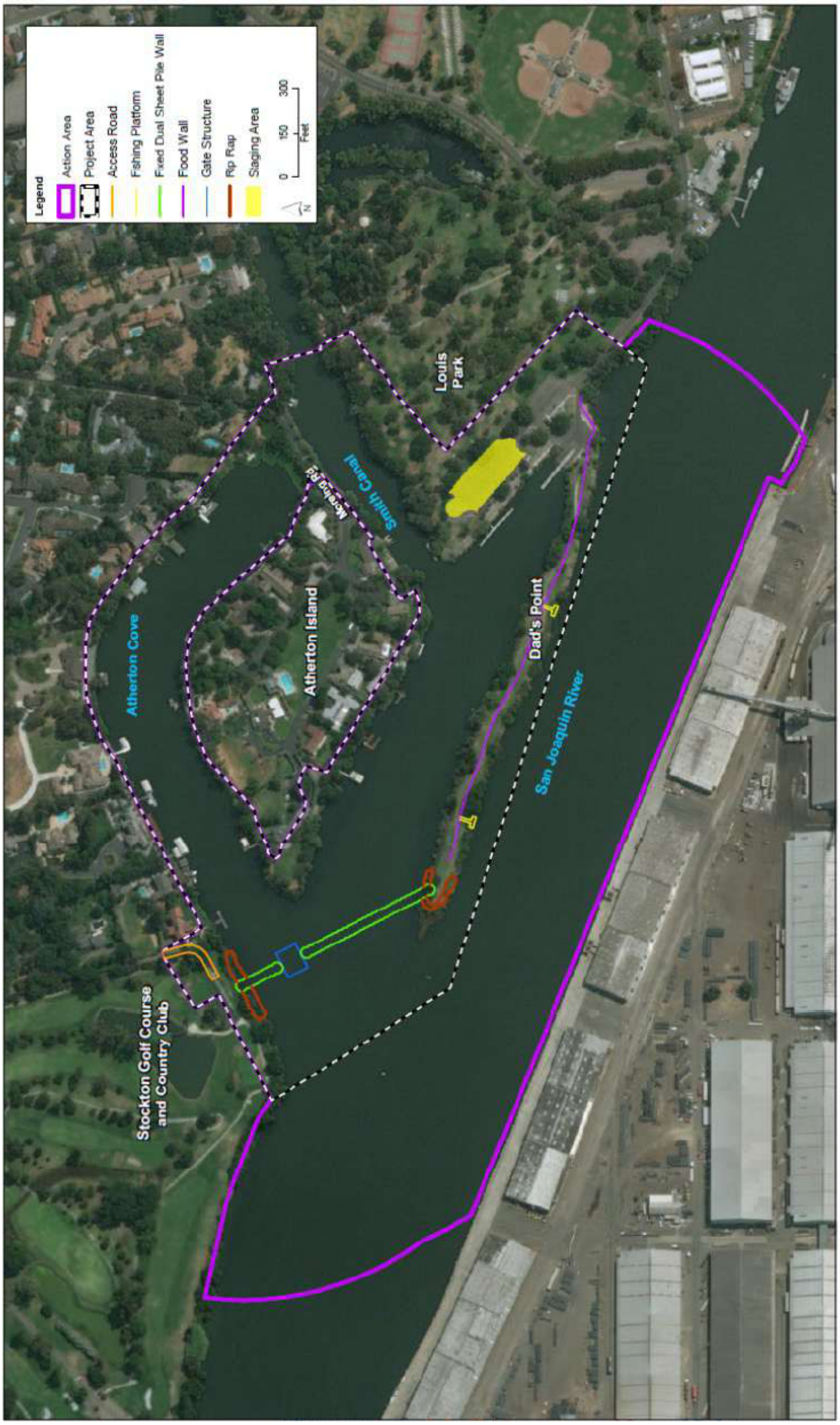

Figure 2. Proposed Action Area (BA 2018)

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the action area, without the consequences to the listed species or designated critical habitat caused by the proposed action. The environmental baseline includes the past and present impacts of all Federal, State, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1. Previously Completed Construction Components of Smith Canal

The following activities completed under the previous biological opinions will be used to inform the anticipated effects of similar activities on the listed species for the remainder of the proposed action (Year 4 to Year 7, 2023-2026). From Year 1 through Year 3 (i.e., 2020, 2021, and 2022), SJAFCA completed approximately 65 percent of the Proposed Project as described below. In 2019, SJAFCA completed the test pile program:

Test Pile Program (2019)

During 2019 activities, SJAFCA conducted a test pile program during the in-water work window (July 15-November 1), which involved vibratory and impact driving a single 20-inch steel flat web sheet pile and "H" pile in three separate locations along the alignment of the cellular sheet pile wall across the mouth of Atherton Cove. The in-water work window specific for this test pile driving was through November 11 only. The purpose of the TPP was to ascertain site-specific subsurface conditions and responses. During the test pile program, SJAFCA evaluated peak and cumulative sound exposure levels during pile driving operations with and without bubble curtain and conducting five cone penetration tests across the cellular sheet pile wall alignment.

Year 1 (2020) Project Activities

Year 1 activities consisted primarily of mobilization of labor, equipment, and materials at the staging area and gate location at the mouth of Smith Canal, installation of a ring cofferdam to isolate the gate construction area, installation of foundation pipe piles for the gate structure, and seasonal demobilization of the in-water work area.

Year 2 (2021) Project Activities

Year 2 Project activities included installation of the gate foundation within the ring cofferdam, grading and installation of a sheet pile floodwall along the length of Dad's Point in Louis Park, dredging near the tip of Dad's Point, installation of 19 of 26 southern floodwall cells (cells A through S) between the ring cofferdam and the tip of Dad's Point, and installation of fishing pier piles on Dad's Point.

Year 3 (2022) Project Activities

Year 3 Project activities included installation of and work on the operable gate structure within the ring cofferdam, installation of seven southern floodwall cells (cells T through Z, installation of 3 of 8 northern floodwall cells (cells AA through CC) between the ring cofferdam and the Stockton Golf and Country Club, placement of granular fill within 19 south floodwall cells (cells A through S, Figure 1), installation of fishing pier decks on Dad's Point.

2.4.2. Occurrence of Listed Species and Critical Habitat in the Action Area

The federally listed anadromous species that use and occupy the action area are migrating adult and juvenile CCV steelhead and CV spring-run Chinook salmon, and juvenile, subadult and adult sDPS green sturgeon. The action area is within designated critical habitat for CCV steelhead and green sturgeon. The San Joaquin River mainstem in the action area is the primary migration corridor for both adult and juvenile CV spring-run Chinook salmon and CCV steelhead life stages spawned in the San Joaquin River Basin to the Delta, which contains important rearing habitat for juveniles. All anadromous fish that utilize the San Joaquin River Basin must also pass by this location at least twice to successfully complete their life histories. Juvenile (including subadult) sDPS green sturgeon may be present throughout the Delta during every month of the year, whereas spawning and post-spawn adults are unlikely to migrate through the action area because their primary migratory route between the ocean and upstream spawning habitats lies predominantly in the Sacramento River and its tributaries.

2.4.2.1 CCV steelhead

The life history strategies of steelhead are variable between individuals, and it is important to take into account that CCV steelhead are iteroparous (i.e., can spawn more than once in their lifetime) (Busby et al. 1996), and therefore may be expected to emigrate back down the system after spawning. As such, the determination of the presence or absence of CCV steelhead in the Delta accounted for both upstream and downstream migrating adult steelhead (kelts).

Adult CCV steelhead enter freshwater in August (Moyle, 2002) and peak migration of adults moving upriver occurs in August through September (Table 4, Hallock et al. 1957). Adult CCV steelhead will hold until flows are high enough in the tributaries to migrate upstream where they will spawn from December to April (Hallock et al. 1961). After spawning, most surviving steelhead kelts migrate back to the ocean and reach the Sacramento River during March and April, and have a high presence in the Delta in May. Migrating adult CCV steelhead through the San Joaquin River are present from July to March, with highest abundance between December and January (Table 5). Small, remnant populations of CCV steelhead are known to occur in the Stanislaus River and the Tuolumne River and their presence is assumed on the Merced River due to proximity, similar habitats, historical presence, and recent otolith chemistry studies verifying at least one steelhead in the limited samples collected from the river (Zimmerman et al. 2008). Outmigrating juveniles from these tributaries would have to pass through the action area during their emigration to the ocean. Juveniles would emigrate from February through June, with the core of their migration occurring March through May.

The proposed construction period for this proposed action in the mainstem San Joaquin portion of the action area is from July 1 through November 30 for in 2023 and 2024. The proposed warranty testing period is from July 1 through November 30 in 2024 and from July 15 to October 15 in Year 2025. The proposed warranty repair work is from July 15 to October 15 in 2025 and 2026. This will overlap with the adult CCV steelhead migration period in the San Joaquin River Basin (i.e., the months of September, October, and November).

However, the long-term operations of the project's flood control gates in Smith Canal may overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high tides or flood events, which will also likely trigger fish movements. Additionally, the environmental effects of the long-term vegetation policies along the proposed action's levees will overlap with fish presence into the future. Because of the close proximity of the canal to San Joaquin River, a migratory corridor for fish, it is possible that fish can enter the canal through the cove.

Table 5. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration

Time Period and Location	Early Jan	Late Jan	Early Feb	Late Feb	Early Mar	Late Mar	Early Apr	Late Apr	Early	Late May	Early Jun	Late Jun	Early Jul	Early Jul	Early	Late Aug	Early Sep	Late Sep	Early Oct	Late Oct	Early	Late Nov	Early Dec	Late Dec
[1]Sacramento R. at Fremont Weir	L	L	L	L	L	N	N	N	N	N	N	L	L	L	L	M	H	H	H	M	L	L	L	L
[2]Sacramento R. at RBDD	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	L	M	M	H	M	L	L	L	L
[3]Mill & Deer Creeks	M	M	H	M	M	L	L	L	L	L	L	L	N	N	N	N	N	N	M	H	H	L	L	L
[4]Mill Creek at Clough Dam	L	L	M	H	M	M	L	L	N	N	N	N	N	N	N	N	N	L	M	H	H	H	M	M
[5]San Joaquin River	H	H	M	M	L	L	N	N	N	N	N	N	L	L	L	L	M	M	M	M	M	M	H	H

(b) Juvenile migration

Time Period and Location	Early Jan	Late Jan	Early Feb	Late Feb	Early Mar	Late Mar	Early Apr	Late Apr	Early	Late May	Early Jun	Late Jun	Early Jul	Early Jul	Early	Late Aug	Early Sep	Late Sep	Early Oct	Late Oct	Early	Late Nov	Early Dec	Late Dec
[1,2]Sacramento R. near Fremont Weir	L	L	L	L	M	M	M	M	M	M	M	M	L	L	L	L	L	L	M	M	M	M	L	L
[6]Sacramento R. at Knights Landing	H	H	H	H	M	M	M	M	L	L	L	L	N	N	N	N	N	N	N	N	L	L	L	L
[7]Mill & Deer Creeks (silvery parr/smolts)	L	L	L	L	M	H	H	H	H	H	L	L	N	N	N	N	N	N	L	L	L	L	L	L
[7]Mill & Deer Creeks (fry/parr)	L	L	L	L	L	L	M	M	H	H	H	H	N	N	N	N	N	N	M	M	M	M	M	M
[8]Chipps Island (clipped)	M	M	H	H	M	M	L	L	L	L	N	N	N	N	N	N	N	N	N	N	N	N	L	L
[8]Chipps Island (unclipped)	M	M	M	M	H	H	H	H	H	H	M	M	L	L	N	N	N	N	N	N	N	N	L	L
[9]San Joaquin R. at Mossdale	N	N	L	L	M	M	H	H	H	H	L	L	N	N	N	N	N	N	L	L	N	N	N	N
[10]Mokelumne R. (silvery parr/smolts)	L	L	M	M	M	M	H	H	H	H	M	M	M	M	N	N	N	N	N	N	N	N	N	N
[10]Mokelumne R. (fry/parr)	N	N	L	L	L	L	L	L	M	M	H	H	M	M	N	N	N	N	N	N	N	N	N	N
[11]Stanislaus R. at Caswell	L	L	M	M	H	H	M	M	M	M	L	L	N	N	N	N	N	N	N	N	N	N	N	N
[12]Sacramento R. at Hood	L	L	H	H	H	H	H	H	H	H	H	N	N	N	N	N	N	N	N	N	L	L	L	L

Sources: [1](Hallock 1957); [2](McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson & Merrick 2012); [8]NMFS analysis of 1998-2011 USFWS data; [9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by FishBio) summarized by John Hannon (Reclamation) ; [12](Schaffter 1980).

Darker shades indicate months of greatest relative abundance.

Relative Abundance Symbol Key: H = High M = Medium L = Low N = Not Present

2.4.2.1.1. CCV steelhead critical habitat

The PBFs for CCV steelhead critical habitat in the action area include freshwater migration corridors and rearing habitat. The freshwater migration utility in the action area is of fair quality, since flows of the lower San Joaquin River are typically of adequate magnitude, quality, and temperatures to support adult and juvenile migration. Most importantly, this section of CCV steelhead critical habitat serves as a migration corridor for all of the adults and juveniles produced and supported by the San Joaquin River and its major tributaries.

During the summer months, migration and rearing habitat is of poor quality due to unsuitable water temperatures and low flows. In addition, rearing habitat is poor as the San Joaquin River is leveed and channelized. The floodplain habitat that would otherwise normally exist has been largely removed near the action area due to the high levees, which limits the value of the area for juvenile rearing. Migratory habitat for adults and juveniles would likely not be impacted due to the project timing because the work window is mostly outside of their migration periods.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for the CCV steelhead DPS. A large fraction of the CCV steelhead smolts originating in the San Joaquin River Basin will likely pass downstream through the action area within the San Joaquin River mainstem channel, particularly if there is a fish barrier at the Head of Old River (placed from April to May) to prevent smolt entrance into that route. Likewise, adults migrating upstream to spawn are likely to pass through the action area within the mainstem of the San Joaquin River to reach their upstream spawning areas in the San Joaquin River basin. Therefore, it is of critical importance to the long-term viability of the CCV steelhead to maintain a functional migratory corridor and freshwater rearing habitat through the action area to sustain the Southern Sierra Diversity Group, and provide the necessary spatial diversity to aid in recovery.

2.4.2.2. CV spring-run Chinook salmon

Typical CV spring-run Chinook salmon life history patterns have adults returning to freshwater basins in March (Table 6). Capitalizing on spring-time runoff, adults travel to holding pools where available in preparation to over-summer. Adults arrive in an immature state and hold over the summer months and develop gonads until ready to spawn in late summer through mid-autumn.

Until recently, CV spring-run Chinook salmon were considered functionally extirpated from the Southern Sierra Nevada diversity group despite their historical abundance in the San Joaquin River Basin (NMFS 2016a). There have been observations of low numbers of spring-time running Chinook salmon returning to major San Joaquin River tributaries that exhibit some typical spring-run life history characteristics. While the genetic disposition of such fish remains inconclusive, the implementation of reintroduction of the CV spring-run Chinook salmon into the San Joaquin River has begun and has resulted in wild-spawned juvenile spring-run Chinook salmon since 2016 (NMFS 2021). These juveniles are imprinted to the upper San Joaquin River mainstem below Friant Dam, and are expected to return as adults when volitional passage is achieved and river conditions are suitable (NMFS 2016a). Additionally, CV spring-run Chinook salmon adults have returned to the San Joaquin River Restoration Program area for three consecutive years (2019, 2020, and 2021) (NMFS 2021; SJRRP preliminary data from Zachary Sutphin, Bureau of Reclamation, April 2021).

Based on known CV spring-run Chinook salmon life history timing and limited information of use of the San Joaquin River Basin, juveniles are expected in the action area November through May during their emigration. Returning adults are expected to travel through the action area from March through June. Timing of CV spring-run Chinook salmon use of the action area would depend on in-river water being adequate in quality and temperature. Life history stage timelines are expected to differ slightly between the Sacramento River and San Joaquin River basins. The proposed construction period for the Project's actions in the mainstem San Joaquin River portion of the action area is from July 1 through November 30 in Years 4 (2023) and 5 (2024) and mid-July through mid-October in Years 6 (2025) and 7 (2026). There is little likelihood that either adult or juvenile life history stages of CV spring-run would overlap with this timing. However, the long-term operations of the proposed project's flood control gates in Smith Canal would overlap with both adult migration upstream, and juvenile migration downstream as this is likely to occur during the winter when river levels are expected to rise in response to high tides or flood events, which will also likely trigger fish movements.

Table 6. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River.

(a) Adult Migration

Time Period and Location	Early Jan	Late Jan	Early Feb	Late Feb	Early Mar	Late Mar	Early Apr	Late Apr	Early	Late May	Early Jun	Late Jun	Early Jul	Early Jul	Early	Late Aug	Early Sep	Late Sep	Early Oct	Late Oct	Early	Late Nov	Early Dec	Late Dec
Sac. River basin[a,b]	**N**	**N**	**N**	**N**	**M**	**M**	**M**	**M**	**H**	**H**	**H**	**H**	**M**	**M**	**M**	**M**	**M**	**M**	**L**	**N**	**N**	**N**	**N**	**N**
Sac. River Mainstem[b,c]	**N**	**L**	**L**	**L**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Mill Creek[d]	**N**	**N**	**N**	**N**	**L**	**L**	**M**	**H**	**H**	**H**	**H**	**M**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Deer Creek[d]	**N**	**N**	**N**	**N**	**L**	**L**	**M**	**H**	**H**	**H**	**H**	**M**	**M**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
Butte Creek[d,g]	**N**	**N**	**L**	**M**	**M**	**M**	**M**	**H**	**H**	**H**	**H**	**M**	**L**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**
(b) Adult Holding[a,b]	**N**	**N**	**N**	**L**	**L**	**M**	**M**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**H**	**M**	**M**	**L**	**L**	**N**	**N**	**N**	**N**	**N**
(c) Adult Spawning[a,b,c]	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**N**	**L**	**M**	**H**	**H**	**M**	**L**	**N**	**N**	**N**	**N**

(d) Juvenile Migration

Time Period and Location	Early Jan	Late Jan	Early Feb	Late Feb	Early Mar	Late Mar	Early Apr	Late Apr	Early	Late May	Early Jun	Late Jun	Early Jul	Early Jul	Early	Late Aug	Early Sep	Late Sep	Early Oct	Late Oct	Early	Late Nov	Early Dec	Late Dec
Sac. River Tribs[e]	M	M	M	M	M	M	N	N	N	N	N	N	N	N	N	N	N	N	M	M	H	H	H	H
Upper Butte Creek[f,g]	H	H	H	H	M	M	M	M	M	M	L	L	N	N	N	N	N	N	L	L	L	L	H	H
Mill, Deer, Butte Creeks[d,g]	H	H	H		M	M	M	M	M	M	L	L	N	N	N	N	N	N	L	L	L	L	L	L
Sac. River at RBDD[c]	H	H	L	L	L	L	L	L	L	N	N	N	N	N	N	N	N	N	N	N	H	H	H	H
Sac. River at KL[h]	M	M	M	M	H	H	H	H	M	M	N	N	N	N	N	N	N	N	N	N	M	M	H	H

Sources: [a]Yoshiyama et al. (1998); [b]Moyle (2002); [c]Myers et al. (1998); [d]S. T. Lindley et al. (2004); [e]CDFG (1998); [f]McReynolds, Garman, Ward, and Plemons (2007); [g]P. D. Ward, McReynolds, and Garman (2003); [h]Snider and Titus (2000)

Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

Darker shades indicate months of greatest relative abundance.

Relative Abundance Symbol Key: H = High M = Medium L = Low N = Not Present

(Used for reference for the San Joaquin River). Darker shades indicate months of greater relative abundance.)

2.4.2.3. sDPS green sturgeon

Adult sDPS green sturgeon enter the San Francisco Bay starting in February, have been recorded in San Pablo Bay in March (Heublein et al., 2008), and in the Sacramento River system between late February and late July (Moyle et al., 1995). In general, sDPS green sturgeon enter the San Francisco Bay estuary in winter and continue upstream to their spawning grounds from mid-winter to late-summer. Spawning occurs from April to July in the mainstem Sacramento River (Poytress et al. 2015) and Feather River (Seesholtz et al. 2015). Adults have been recorded out-migrating from the Sacramento River in the fall (November to December) and summer (June to August) (Heublein et al., 2008). It has been suggested that spawning may also occur in the San

Joaquin River (Moyle et al. 1995) however, this was based on a 1-year study in the 1960's collecting a large number of young green sturgeon during the summer at a shallow shoal area in the lower San Joaquin River (Radtke 1966). Data on sDPS green sturgeon distribution is extremely limited and out-migration appears to be variable occurring at different times of year. Seven years of CDFW catch data for adult sDPS green sturgeon show that they are present in the Delta during all months of the year. Adult and juvenile sDPS green sturgeon are therefore assumed to be present in the Delta year-round (Table 7).

Prior to October 2017, all accounts of sDPS green sturgeon sightings in the San Joaquin River Basin were anecdotal at best or misidentified white sturgeon (Gruber et al. 2012, Jackson et al. 2016). During late October in 2017, an adult sDPS green sturgeon was sighted in the Stanislaus River near Knights Ferry by a fish biologist and its identity was genetically confirmed by genetic analysis of green sturgeon environmental DNA in the surrounding water (Breitler, 2017). This is the first confirmed sighting of a green sturgeon in a San Joaquin River tributary, and indicates that adults are able to pass upstream of the proposed action area given river flows of suitable quality and amount. In addition, on April 11, 2020, another adult green sturgeon was captured within the boundaries of the San Joaquin River Restoration area (just upstream with the Merced River confluence in the vicinity of Hills Ferry, California)(Root et al. 2020). Spawning activities in the San Joaquin River Basin have not been recorded and production of juveniles from the Stanislaus River is not considered likely in the near future. However, implementation of recovery actions, increased protections under the ESA since listing may improve conditions leading to and potential recolonization in the San Joaquin Basin.

While the San Joaquin River Basin may not currently produce juvenile sDPS green sturgeon, juveniles may use both estuarine and freshwater portions of the Delta to rear for one to three years prior to exiting the system and entering the Pacific Ocean. During this period, they may range and stray up non-natal waterways searching for appropriate food resources, water quality conditions, and shelter. Therefore, foraging juveniles, subadults, and adults may be found in the San Joaquin River mainstem at the location of the proposed action at nearly any time of year, depending on the local water depth, temperature, and quality.

For the purpose of analyzing the impacts of this action, both adult and juvenile sDPS green sturgeon are expected to occur in the action area, but in low numbers. The Delta serves as an important migratory corridor for adults during their spawning migrations, and as year-round rearing habitat for juveniles. Both non-spawning adults and subadults use the Delta and estuary for foraging during the summer. Since there are no physical barriers to sDPS green sturgeon moving into the action area from the waters of the Delta adjacent to the action area during their rearing or foraging behaviors, presence in the action area is seen as feasible and likely.

Since adult, subadult, and juvenile sDPS green sturgeon may be present in the Delta year-round, the construction period will overlap with their presence. Likewise, the long-term operations of the proposed project flood control gates in Smith Canal will overlap with adult, subadult, and juvenile presence in the Delta during the winter when river levels are expected to rise in response to high astronomical tides or flood events occur and the gates are operated. Likewise, the environmental effects of the long-term vegetation policies along the proposed project levees will overlap with fish presence into the future.

Table 7. The temporal occurrence of (a) adult, (b) larval (c) juvenile and (d) subadult coastal migrant sDPS of green sturgeon. Locations emphasize the Central Valley of California. Darker shades indicate months of greatest relative abundance.

(a) Adult-sexually mature (≥145 – 205 cm TL for females and ≥ 120 – 185 cm TL for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Upper Sac. River[a,b,c,i]	Low	Low	Medium	Medium / High	High	High / Medium	Medium	Medium	Medium	Low	Low	Low
Feather, Yuba Rivers[k]	Low	Low	Medium	Medium / High	High	High / Medium	Medium	Medium	Medium	Low	Low	Low
SF Bay Estuary[d,h,i]	Low	Low	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Low	Low	Low

(b) Larval and juvenile (≤10 months old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
RBDD, Sac River[e, j]					Medium / High	High	High	Medium				
GCID, Sac River[e, j]					Medium	High	High	Medium	Low	Low		

(c) Older Juvenile (> 10 months old and ≤3 years old)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
South Delta*[f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[f]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
Sac-SJ Delta[e]				Medium	Medium	Medium	Medium	Medium	Medium	Medium		
Suisun Bay[e]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

(d) SubAdult/non-sexually mature (approx. 75 cm to 145 cm for females and 75 to 120 cm for males)

Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Pacific Coast[c,g]	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium
San Francisco and San Pablo Bay	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium	Medium

Relative Abundance: = High = Medium = Low

* Fish Facility salvage operations

Sources: [a]USFWS (2002); [b]Moyle *et al*. (1992); [c]Adams *et al*. (2002) and NMFS (2005); [d]Kelly *et al*. (2007); [e]CDFG (2002); [f]IEP Relational Database, fall midwater trawl green sturgeon captures from 1969 to 2003; [g]Nakamoto *et al*. (1995); [h]Heublein (2009); [i]Gleason et al. 2008, [j]Poytress *et al.* (2011, 2012), [k]Alicia Seesholtz, DWR, personal communication.

2.4.2.4. sDPS green sturgeon critical habitat

The action area is close to the southernmost extent of sDPS green sturgeon designated critical habitat in freshwater, which ends just north of the confluence of the San Joaquin River and the

Stanislaus River. There is little data regarding the services this portion of their critical habitat offers sDPS green sturgeon, except that the San Joaquin River is believed to have historically supported sDPS green sturgeon populations and therefore they must have used this area for migration and perhaps also for foraging and rearing to some degree.

The PBFs of sDPS green sturgeon critical habitat included within the action area are: (1) food resources; (2) adequate water flow regime for all life stages; (3) water quality; (4) and adequate water depth for all life stages. The San Joaquin River mainstem in this section has sufficient depth to support even adult passage, though as stated before only one adult has been observed in the Stanislaus River to date. Spawning in the San Joaquin River Basin may not be currently possible for sDPS green sturgeon given the extent of degradation prevalent throughout the San Joaquin River Basin. Therefore, juveniles are not expected to be produced in this system for some time; however, juveniles produced by the Sacramento River Basin could range into this area during their long rearing period in the Delta.

Even though the habitat has been substantially altered and its quality diminished through years of human actions, its conservation value remains high for sDPS green sturgeon. Due to a deficiency of monitoring data directed at this species, an unknown fraction of the sDPS population utilizes the middle and upper San Joaquin River reaches within the Delta. Currently even less is known about utilization of the San Joaquin River upstream of the Delta. However, designated critical habitat occurs in the action area and includes the San Joaquin River upstream to the limits of the legal Delta (Vernalis) on the San Joaquin River. Preservation of the functionality of the PBFs within this region is important to the long-term viability of the sDPS green sturgeon population by providing suitable habitat for the rearing of juveniles, and the foraging and migratory movements of adults.

2.4.3. Factors Affecting Listed Species and Critical Habitat in the San Joaquin River

The action area encompasses a small portion of the area utilized by ESA-listed species. Many of the factors affecting these species in the action area are considered the same as throughout their range, as discussed in section 2.2 *(Rangewide Status of the Species and Critical Habitat)* and section 2.4 *(Environmental Baseline)* of this biological opinion. Specifically, levee armoring and channelization, alteration of river flows and timing, reduction of riparian corridors and associated shaded riverine aquatic (SRA) vegetation and the introduction of point and non-point contaminants and are incorporated here by reference. Other factors that impact listed species and critical habitat specific to the action area are discussed below.

2.4.3.1. San Joaquin River Basin water resources

The San Joaquin River is the longest river in California, covering 366 miles, and is considered California’s second largest river in California according to average total annual flow (the Sacramento River being the largest). The San Joaquin River has an average mean flow of six million-acre feet per year compared to the Sacramento River’s 18 million-acre feet (Reclamation, 2016). It drains the central and southern portions of the Central Valley and joins the Sacramento River near the center of California to form the Delta, the largest estuary on the west coast of the United States. The San Joaquin River is primarily fed (receiving two thirds of its water) by the melting snowpack of the Sierra Nevada Mountains.

The primary storage reservoir on the San Joaquin River is Friant Dam, completed in 1944. Friant Dam created Millerton Lake/Reservoir and can hold more than 500 thousand-acre feet in water storage. Friant Dam diverts Sierra-Nevada snowmelt water into two canals, the Friant-Kern Canal and the Madera Canal, both of which primarily support the irrigation needs of agriculture as part of the Central Valley Project (CVP). Except for releases to manage floods and to meet the requirements of riparian water rights holders, the entirety of San Joaquin River's flow is impounded by the Friant Dam and directed into the canals for distribution. See the existing Coordinated Long-term Operation of the CVP and SWP, and their effects on ESA-listed species and their critical habitats that have been analyzed in the 2009 NMFS CVP Operations Biological Opinion (NMFS 2009) for more information on the effects of federal and state water management on listed species under NMFS jurisdiction. In a typical year, all of the San Joaquin River's flows were allocated to water users. Following, construction of Friant Dam and associated water management practices, the river ran dry annually for a 40-mile stretch, only connecting to the Delta during flood releases from Millerton. In recent years, mandated river restoration flows have reconnected the San Joaquin River to the Delta (see section 2.4.2.3, *The San Joaquin River Restoration Program*) unless there is a "call" on Friant from CVP Exchange Contractors which can lead to dewatering of the River during some drought years.

2.4.3.2. San Joaquin River diversions

The Patterson Irrigation District (PID) Fish Screen Intake is located near the City of Patterson, in Stanislaus County, California. The project is located upstream of West Stanislaus Irrigation District (WSID) project, on the west bank of the San Joaquin River, between Merced and Tuolumne Rivers. The diversion consists of seven pumps with a combined pumping capacity of 195 cubic-feet-per-seconds (cfs). PID's original pump station facility used an unscreened intake that had the ability to entrain listed anadromous fish as they migrated through the area. The existing pump station facility could not be retrofitted with a fish screen that would comply with NMFS and CDFW fish screen criteria. As a result, PID constructed a new 195 cfs pump station diversion with a screen with reinforced concrete that is 144 feet long supported on 422 steel piles. The fish screen includes ten stainless steel, high profile bars.

Banta Carbona Irrigation District (BCID) Fish Screen and Fish Bypass System is located near the City of Tracy and is downstream from the San Joaquin River and Stanislaus River confluence. The diversion has a 250 cfs capacity. The fish screen facility consists of a V-shaped screen located within the leveed canal close to the river and 18 panel screens installed vertically in a V configuration with nine panels to a side. Each panel is 6'1" tall and 11'6" wide. Fish pass the screens and are pumped through a Hidrostal fish pump to the fish return pipeline on the north levee. This pipeline returns fish back to the river downstream from the diversion point. The positive barrier fish screen is fully consistent with the fish screen criteria of the regulatory agencies including NMFS, CDFW, and the U.S. Fish and Wildlife Service.

2.4.3.3. The San Joaquin River Restoration Program

The SJRRP is the result of a settlement that was reached in 2006 on an 18-year lawsuit between federal agencies, the Natural Resources Defense Council, and the Friant Water Users Authority (SJRRP, 2009). The settlement is based on two goals: 1) Restore and maintain fish populations in "good condition" in the mainstem of the San Joaquin River below Friant Dam to the confluence of the Merced River, including naturally-reproducing and self-sustaining populations of salmon and other fish; and 2) Reduce and avoid adverse water supply impacts to all Friant Division long-term contractors caused by the interim and restoration flows provided for in the settlement.

As previously identified, some critical recovery actions identified in the NMFS recovery plan are achieved through the implementation of settlement goal #1. Though this settlement and the SJRRP actions are limited to the restoration area (the San Joaquin River mainstem from Friant Dam to the Merced River) the restoration of volitional fish passage would increase the use of the San Joaquin River mainstem within the action area of this project by both adult and juvenile salmonid migration.

2.4.3.4. Mitigation banks

There are several conservation or mitigation banks approved by NMFS with service areas that include the action area considered in this opinion. These banks may offer salmonid credits or credits that would benefit salmonid habitat.

Bullock Bend Mitigation Bank: Established in 2016, the Bullock Bend Mitigation Bank is a 116.15-acre floodplain site along the Sacramento River at the confluence of the Feather River (Sacramento River Mile 80) and is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are salmonid floodplain restoration, salmonid floodplain enhancement, and salmonid riparian forest credits available. To date, there have been 12.5 of 119.65 credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CV spring-run Chinook salmon, CCV steelhead as analyzed in this opinion, and sDPS green sturgeon.

Cosumnes Floodplain Mitigation Bank: Established in 2008, the Cosumnes Floodplain Mitigation Bank is 472-acre floodplain site at the confluence of the Cosumnes and Mokelumne Rivers (Mokelumne River Mile 22) and is approved by NMFS to provide credits for impacts to CCV steelhead. There are shaded riverine aquatic, floodplain riparian, and floodplain mosaic wetlands credits available. To date, there have been 22.39 of 38.13 floodplain credits sold and the ecological value (increased rearing habitat for juvenile salmonids) of the sold credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

Fremont Landing Conservation Bank: Established in 2006, the Fremont Landing Conservation Bank is a 100-acre site near the confluence of the Feather River and the Sacramento River, at river mile 78 through 80, on the west bank of the Sacramento River. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Out of 100 acres of potential credits, 28.283 acres have been sold/withdrawn and the ecological value (increased rearing habitat for juvenile salmonids) of these credits are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

Liberty Island Conservation Bank: Established in 2010, the Liberty Island Conservation Bank is a 186-acre site located at the southern end of the Yolo Bypass on Liberty Island in the Delta. Out of the credits relating to salmonid restoration or preservation, 27.67 acre have been sold/withdrawn. It is approved by NMFS to provide credits for impacts to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. There are riparian shaded aquatic, salmonid preservation, and salmonid restoration credits available, and the ecological value of the sold credits (increased rearing habitat for juvenile salmonids) are part of the environmental baseline. All features of this bank are designated critical habitat for CCV steelhead as analyzed in this opinion.

2.4.4. NMFS Salmon and Steelhead Priority Recovery Plan Action

NMFS' Recovery Plan for CCV steelhead and CV spring-run Chinook salmon (NMFS, 2014) identifies recovery goals for the San Joaquin River Basin populations whose range includes the proposed action area. Recovery efforts focus on addressing several key stressors vital to both CCV steelhead and CV spring-run Chinook salmon: (1) elevated water temperatures affecting adult migration and holding; (2) low flows and poor fish passage facilities, affecting attraction and migratory cues of migrating adults; and (3) possible catastrophic events (e.g., catastrophic wildfire).

2.4.4.1. CCV Steelhead DPS

The NMFS Recovery Plan (NMFS, 2014) strategy for CCV steelhead lists the San Joaquin River's eastside tributaries (Stanislaus, Tuolumne, and Merced Rivers) as Core 2 populations downstream of major dams, and as candidates to reach viable population status if reintroduced upstream of the dams, and lists the San Joaquin River, downstream of Friant Dam, as a candidate to reach viable population status.

2.4.4.2. CV Spring-run Chinook salmon

The Recovery Plan (NMFS, 2014) indicates that for CV spring-run Chinook salmon, re-establishing two viable populations in the San Joaquin River Basin would be necessary for recovery.

2.4.4.3. sDPS green sturgeon

The San Joaquin River is not known to currently support sDPS green sturgeon spawning. Currently, he San Joaquin River Basin is not a main focus of their recovery plan. Nonetheless, sDPS green sturgeon occupy the lower San Joaquin River to an unknown extent as evidenced by the detection of an individual adult in the Stanislaus River in October 2017. This highlights that passage for adults is possible during certain river conditions. However, the recovery plan is not likely to be modified to include recovery recommendations until adult spawning or juvenile reproduction occurs (NMFS, 2018) which is problematic due to the absence of green sturgeon monitoring activities in the watershed.

2.4.5. Summary of Monitoring and Effects from Year 2 (2021) and Year 3 (2022) Activities of Smith Canal Gate Project

This biological opinion is the third reinitiation of ESA consultation with NMFS (2021, 2019, 2016). Over the course of construction of the project under these opinions, SJAFCA completed construction of approximately 65 percent of the total project by October, 2022. These in-water completed components include: completion of the gate, completion of 19 cells in the flood wall. Monitoring during construction analyzed numerous variables associated with water quality and underwater noise levels.

2.4.5.1 Summary of Underwater Noise Levels from Pile Driving as Measured in 2021 and 2022

A summary of underwater noise levels and the distance to compliance with the BO-specified thresholds are provided in Table 8 for Year 2 (2021) for vibratory pile driving events.

RMS

Table 8. Measured underwater peak and RMS noise levels for unattenuated vibratory pile-driving events and distance to NMFS' 2019 BO thresholds in Year 2 (2021) of construction.

Year	Number of Piles Driven	Pile Types	Noise Level (dB re:1μPa)* Peak Max	Noise Level (dB re:1μPa)* RMS Average	Distance to Threshold (m) Peak Max	Distance to Threshold (m) RMS Average
2021 (Year Two) July 1 – November 30	109	Flat and H-piles	199.1	113.4	1.8	< 1
2021 July 1-14 Only	9	H-piles	176	91.1	0.2	< 1
2021 October 16-November 30 Only	41	Flat and H-piles	166.5	120.8	0.04	< 1

* Values calculated at a distance of 10 meters from the pile.

The highest instantaneous peak values measured during vibratory driving in 2021 was 190.2 dB dB (Table 8). Based on these Project-specific data, peak underwater noise levels did not exceed 206 dB beyond 1.8 m and, therefore, were below the 18 m threshold.

Of the 69 daily average RMS values measured in 2021 and 2022, 78% (n=54) reached the threshold RMS value of 150 dB within 10 m of the flat sheet being driven with an impact hammer and all 69 daily average RMS values reached the threshold value of 150 dB within 300 m of the flat sheets being driven. In no cases did the daily average RMS values exceed 150 dB beyond the Project-specific allowable take distance of 2,154 m as specified in the 2021, NMFS biological opinion.

Peak

Sixty-nine daily maximum peak values measured in 2021 and 2022; 86% (n=59) reached the threshold peak value of 206 dB within 1 meter of the flat sheet being driven with an impact hammer. Moreover, all 69 daily maximum peak values reached the peak value of 206 dB within 4.9 meters of the flat sheets being driven. The calculated maximum distance to compliance associated with the maximum peak value was 1.8 m. During the first two weeks of July 2021 and the period of October 16-November, 2021, maximum instantaneous peak values did not exceed 176 dB and all measurements were in compliance with the 206 dB threshold within 0.2 m of the piles being installed (Table 8). In no cases did the peak values exceed 206 dB beyond the NMFS-specified “no take” threshold of 10 m nor the Project-specific allowable take distance of 18 m.

Cumulative SEL

No cSEL value could be calculated for 40 of the 69 impact driving days because all SEL values were below the effective quiet value of 150 dB. Of the remaining 29 daily cSEL values measured in 2021, and 2022, 72% (n=21) reached the threshold cSEL value of 187 dB within 10 m of the flat sheet being driven with an impact hammer and all 29 daily cSEL values reached the threshold 187 dB within 60 meters of the flat sheets being driven. In no cases did the cSEL values exceed 187 dB beyond the Project-specific allowable take distance of 1,597 m.

Water Quality

Routine water quality monitoring at locations upstream and downstream of the Project area was conducted during in-water work periods in Years 1, 2, and 3 (2020-2022). Turbidity was measured at two locations: (1) approximately 300 linear feet east of the Project site, and (2) approximately 300 linear feet west of the Project site. All water quality measurements were made near the eastern bank of the San Joaquin River and at mid-depth in the water column.

A summary of results for water quality monitoring for paired upstream and downstream turbidity measurements collected during Years 1 through 3 (2020–2022) of in-water construction are provided in Table 9. None of the downstream turbidity measurements taken from 2020–2022 exceeded the 150 NTU limitation for waters of the Central Delta, as specified in Condition 3.c. of the 401 WQC. The largest increase in downstream turbidity above ambient conditions during the first of in-water construction activity was 61.4 NTU in 2021, which occurred on November 16, 2021. This increase was a one-time event, however, which was the result of simultaneous barge movement and dredge activity; downstream increases in turbidity were typically less than 10 NTU during the first three years of monitoring. Aside from a single measurement on November 16, 2021, the take limit of 50 NTUs above ambient (i.e., upstream) specified in Condition 1.a of the NMFS BO was not exceeded during Years 1–3 of in-water construction activity.

Table 9. Results of Paired Water Quality Measurements Collected during the Smith Canal Gate Project, Years 2020–2022

Year	Turbidity (NTU) Upstream	Turbidity (NTU) Downstream	Turbidity (NTU) Increase above Ambient
2020	0.34 – 67.3	2.48 – 51.2	32.3
2021	0.0 – 63.9	0.0 – 86.4	61.4
2022	1.92 – 27.24	1.85 – 24.30	18.62

A turbidity curtain was deployed at all times during in-water work activity to minimize turbidity outside the turbidity curtain. The most notable increases in turbidity measured at the monitoring locations resulted from barge movements using the tugboat. However, barge movements were infrequent activities that typically lasted a few minutes. The increases in turbidity were generally confined to within a short distance (typically less than 150 feet) of the tugboat and barge, were short in duration (e.g., within 15 minutes).

No construction-related fuels or other materials were observed outside the cofferdam during Year 1 in-water work activities. As reported in the 2020 and 2021 annual reports (ECORP 2020, 2022b), minor accidental spills of non-hazardous clarity hydraulic fluid caused by a leaking hydraulic cylinder seal on the vibratory hammer occurred inside the cofferdam on September 21, 2020, and was contained within the cofferdam until it was cleaned up in accordance with the contractor's spill prevention plan (Shimmick 2020).

During Year 2 of in-water work activities, a minor (less than 5 gallons) accidental spill of non-hazardous clarity hydraulic fluid resulted in a patchy vegetable oil sheen inside and about 10 feet outside the turbidity curtain on August 5 (approximately 0.5 gallon). Another minor spill of non-hazardous vegetable-based clarity hydraulic fluid occurred on October 29, 2021 when a hydraulic hose became caught on dredging equipment and pulled loose and released hydraulic fluid onto the barge, of which 0.5 gallon spilled into the water.

During Year 3 of in-water work activities, minor spills (less than 5 gallons) of non-hazardous clarity hydraulic fluid occurred on August 20 and September 9, 2022, however neither of these spills reached the water.

On each occasion, the contractor followed the spill prevention plan's requirements for a minor spill, which included containment, recovery of spilled material, and cleanup. Disposal of the recovered material occurred per recommendations from California Office of Emergency Services and San Joaquin County.

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action. A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered 50 CFR 402.17(a) and (b).

The following is an analysis of the potential effects to listed fish species that may occur as a result of implementing the proposed action on the San Joaquin River.[1] For our analysis, we have used the presence of listed species in the action area to determine the risk each species and life stage may face if exposed to project impacts. The expected effects of the proposed action include impacts due to: (1) water quality, (2) noise exposure, (3) habitat loss/modification, (4) and operations and maintenance. As described in section 2.1 Analytical Approach, we use completed construction components of Year 2 (2021) and Year 3 (2022) as best available information to inform the anticipated effects of the proposed action (Year 4 through Year 7, 2023-2026).

2.5.1. Effects to species: Water quality, noise exposure, RSP placement, Cone Penetration Tests, effects of structures, operations and maintenance, boat traffic

2.5.1.1 Construction Impacts

Water Quality: Sediment and Turbidity

Construction activities could result in turbidity, suspended sediment concentrations, and contaminant concentrations. Construction activities could disturb sediments and soils within and adjacent to waterways. These activities, including construction of the new tidal gate, use of staging areas, installation of sheet piles, wildlife viewing platforms, riprap placement, and placement of excavated material, could disturb sediments and soils within and adjacent to waterways. Any construction-related erosion or disturbance of sediments and soils would increase downstream turbidity and sedimentation in the project area if soils were transported in river flows. During the long-term period of gate operations, the narrow gate opening (~50 feet) will create a higher velocity flow through the structure than currently exists through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

The abundance, distribution, and survival of fish populations have been linked to levels of turbidity and silt deposition. Prolonged exposure to high levels of suspended sediment could create a loss of visual capability in fish in aquatic habitats within the project area, leading to reduced feeding and growth rates. Such exposure could also result in a thickening of the gills, potentially causing the loss of respiratory function; in clogging and abrasion of gills; and in increased stress levels, which in turn could reduce tolerance to disease and toxicants (Waters

[1] As stated previously, there are no other activities associated with this project.

1995). Turbidity also could result in increased water temperature and decreased dissolved oxygen (DO) levels, especially in low-velocity pools, which can cause stressed respiration.

High levels of suspended sediments could also cause redistribution and movement of fish populations in the San Joaquin River, and could diminish the character and quality of the physical habitat important to fish survival. Deposited sediments can reduce water depths in stream pools and can contribute to a reduction in carrying capacity for juvenile and adult fish (Waters 1995). Increased sediment loading downstream from construction areas could degrade food-producing habitat by interfering with photosynthesis of aquatic flora, and could displace aquatic fauna.

Many fish, including salmonids (Chinook salmon and steelhead), are visual feeders and turbid waters reduce the ability of these fish to locate and capture prey. Some fish, particularly juveniles, could become disoriented and leave the areas where their main food sources are located, ultimately reducing growth rates. Prey of fish populations, such as macroinvertebrates, could be adversely affected by declines in habitat quality (water quality and substrate conditions) caused by increased turbidity, decreased Dissolved Oxygen (DO) content, and an increased level of pollutants.

Avoidance of adverse habitat conditions by fish is the most common result of increases in turbidity and sedimentation (Waters 1995). Fish are not expected to occupy areas unsuitable for survival unless they have no other option. Therefore, increased turbidity attributed to construction activities could preclude fish from occupying habitat required for specific life stages. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 nephelometric turbidity units [NTUs]) that are expected to result from this proposed project. Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates and reduced use of overhead cover. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barret *et al.* 1992).

During installation of the sheet piles, riprap placement, and dredging, there would be an increase in sediment and turbidity. The Smith Canal structure is anticipated to take four additional years for completion, with the majority of the work occurring over two, five-month long (July 1 - November 30) in water work windows (Year 4 (2023) and Year 5 (2024)). During warranty testing/inspection, which is anticipated to occur episodically over a five-month long period (July 1 through November 30) in Year 5 and over a three-month long period (July 15 through October 15) in Year 6 (2025), there would be an increase in sediment and turbidity. During the repair period (if needed), which is anticipated to occur episodically over a 3 ½ month long period (July 15 through October 15) in Year 6 (2025) through Year 7 (2026), there would be an increase in sediment and turbidity. During these periods, NMFS anticipates short-term, localized (no more than 300 feet upstream and downstream) construction related turbidity events will occur. In addition, based on Year 1, 2, and 3 (2020-2022) water quality monitoring information, the turbidity levels stayed below the threshold of 50 NTUs above background.

In-water work activities that would result in increased sediment and turbidity would occur from July 1 to November 30 (2023 and 2024) and July 15 to October 15 (2025 and 2026). This period coincides with the period when CCV steelhead are less likely to be present in the action area although adult CCV steelhead may commence their upstream migration as early as October. Juvenile CCV steelhead would not likely be migrating downstream during this time. There is likely to be no exposure to any CV spring-run Chinook salmon adults based on the expected timing of their life histories. Juvenile and adult CCV steelhead and CV spring-run Chinook salmon are not expected to occur in the project site during the in-water work window due to unsuitable habitat conditions such as warm water temperatures. These species are only likely present within the action area during migration which is largely outside of the proposed construction window. The separation in timing will limit the potential for CV spring-run Chinook salmon and CCV steelhead to be impacted by construction activities. NMFS expects that foraging adult sDPS green sturgeon and rearing juvenile sDPS green sturgeon could be present in the Delta. However, diminished water quality (low DO, low flow, and increased water temperatures) in the action area would likely preclude presence of green sturgeon during the in-water work window.

Installation of the sheet piles and platform pilings is expected to result in short-term, localized increases in turbidity. Therefore, there could be some impacts to the listed species if present during the removal of the cofferdam and ongoing floodwall construction activities. Since in-water work will be extended in Year 4 (2023) and Year 5 (2024), the probability of in-water work overlapping with listed salmonid presence increases and the potential for exposure to elevated turbidity increases. Although the risk of contact is still low, this increases the risk for exposure, resulting in non-lethal adverse effects, including behavioral responses such as displaced feeding and migration delays, for small numbers of each species.

Water Quality: Contaminants

During construction, the potential exists for spills or leakage of toxic substances that could enter the waterways. Refueling, operation, and storage of construction equipment and materials could result in accidental spills of pollutants (e.g., fuels, lubricants, sealants, and oil). Adverse effects to listed fish may result from point and non-point source chemical contaminant discharges within the action area. These contaminants include, but are not limited to ammonia/ammonium, pesticides and herbicides, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into the waterways from shipping and boating activities and from urban activities and runoff. These contaminants may adversely affect fish reproductive success and survival rates. Fish could also be exposed to legacy contaminants during sediment disturbing activities such as dredging.

High concentrations of contaminants can cause short-term and long-term effects to fish. The severity of these effects depends on the contaminant, the concentration, duration of exposure, and sensitivity of the affected life stage. Sublethal effects include increased susceptibility to disease that reduces the overall health and survival of the exposed fish. A long-term effect of contamination is reduced prey availability. Invertebrate prey species survival can be reduced therefore making food less available for fish. Also, fish consuming infected prey can absorb toxins directly. However, only a small number of salmonids would be expected to be exposed to such effects because of the timing of in-water work.

Green sturgeon may be more susceptible to aquatic contaminants since they are benthic foragers. The prey base (green sturgeon food resources) are likely to bioaccumulate some of the contaminants listed in the 303(d) list for impaired waters that are present in the Smith Canal, as green sturgeon are bottom feeders. Studies on white sturgeon found that bioaccumulation of pesticides and other contaminants adversely affect growth and reproductive development (Feist et al. 2005). However, green sturgeon occurrence in the relatively shallow water of the action area during sediment disturbance is likely to be limited because the species tends to occupy deeper water during the day.

With the continued implementation of the water quality conservation measures (as described in the project description), the potential effects from exposure to contaminants are expected to be avoided.

Noise Exposure

2.5.1.2 Vibratory and Impact Pile Driving

Installation of the dolphins, fenders, and construction of flood walls (aka cell walls) will require the use of vibratory and impact pile driving. Table 10 provides a summary of all pile driving activities for the proposed action. During the construction period, steel pipe piles and steel sheet piles will be installed in the river via vibratory pile driving methods to the maximum depth possible or desired, and then via impact pile driving, as necessary, for final setting and then load testing. To ensure in-water pile driving work is completed in two construction seasons, SJAFCA estimated up to 5,000 impact strikes per day are necessary. Most in-water pile driving will be accomplished with a barge-mounted crane. Water depths in the pile driving locations are assumed to be variable but less than five meters overall.

Pile driving near or in water has the potential to kill, injure, and cause delayed death to fish through infection of minute internal injuries, or cause sensory impairments leading to increased susceptibility to predation. The pressure waves generated from driving piles into river bed substrate propagate through the water and can damage a fish’s swim bladder and other internal organs by causing sudden rapid oscillations in pressure, which translates to rupturing or hemorrhaging tissue in the bladder when the air in swim bladders expand and contract (Gisiner 1998, Popper, Carlson et al. 2006). Sensory cells and other internal organ tissue may also be damaged by pressure waves generated during pile driving activities as sound reverberates through a fish’s viscera (Caltrans 2015). In addition, morphological changes to the form and structure of auditory organs (saccular and lagenar maculae) have been observed after intense noise exposure (Hastings and Popper 2005). Smaller fish with lower mass are more susceptible to the impacts of elevated sound fields than larger fish, so acute injury resulting from acoustic impacts are expected to scale upward based on the mass of a given fish. Since juveniles and fry have less inertial resistance to a passing sound wave, they are more at risk for non-auditory tissue damage (Popper and Hastings 2009) than larger fish (yearlings and adults) of the same species. Beyond immediate injury, multiple studies have also shown responses in the form of behavioral changes in fish due to human-produced noises (Wardle et al. 2001, Slotte et al. 2004, Popper and Hastings 2009).

Impact Pile Driving, Effects of Pipe Piles – July 15-October 15

Both flat sheet and pipe piles will be subject to impact driving, however adverse effects from pipe piles are considerably more pronounced than sheet piles and represent a worse-case scenario during the in-water work window. Because pipe piles represent a worse-case scenario they are the focus of this analysis. Based on recommendations from the Fisheries Hydroacoustic Working Group (FHWG), NMFS uses an interim dual metric criteria to assess onset of injury for fish exposed to pile driving sounds (NMFS 2008, Caltrans 2015, Caltrans 2019). The interim thresholds of underwater sound levels denote the expected instantaneous injury/mortality and cumulative injury, as well as a third threshold criteria for behavioral changes to fish. Impact pile driving is expected to produce underwater pressure waves at all three threshold levels. Even at large distances from the pile driving location, underwater pressure changes/noises from pile driving is likely to cause flight, hiding, feeding interruption, area avoidance, and movement blockage when pile driving is ongoing.

For a single strike, the peak exposure level (peak) above which injury is expected to occur is 206 decibels (dB) (reference to 1 micro-pascal [1µpa] squared per second). However, cumulative acoustic effects are expected for any situation in which multiple strikes are made to an object with a single strike peak dB level above the effective quiet threshold of 150 dB. Therefore, the accumulated SEL level above which injury to fish is expected to occur is 187 dB for fish greater than 2 grams in weight, and 183 dB for fish less than 2 grams. If either the peak SEL or the accumulated SEL threshold is exceeded, then physical injury is expected to occur to fish within the estimated distance thresholds. Underwater sound levels below injurious thresholds are expected to produce behavioral changes. NMFS uses a 150 dB root-mean-square (RMS) threshold for behavioral responses in salmonids and green sturgeon. Though the dB value is the same, the 150 dB RMS threshold for behavioral effects is unrelated to the 150 dB effective quiet threshold.

According to the Caltrans pile driving compendium of field data (Caltrans 2012), in-water impact pile driving of the 36-inch diameter steel pipe piles for this project could generate unattenuated underwater sound waves of up to 210 dB peak, 190 dB SEL, and 190 dB RMS, as measured at 10 meters from the strikes, in approximately 5 meters of water depth or less (Table 10). These estimates are calculated from field data gathered from pile driving activities at other locations and are considered informative only, not the definite levels that would be generated by impact pile driving in the San Joaquin River/Smith Canal/Atherton Cove during the course of this project. This is because each pile driving situation is unique and variations in the substrate, channel shape, depth, salinity, and water temperature can alter how the underwater pressure waves propagate and the amount of transmission loss that will dampen the underwater sounds as they travel. -

Table 10. Expected maximum unattenuated hydroacoustic on 36-inch piles from impact pile driving, empirical data from the 2012 FHWG pile driving compendium Caltrans (Caltrans 2012).

Pile Type	Driver Type	Pile Location	Reference Distance	Peak (dB)	SEL (dB)	RMS (dB)
+-	Impact	In water, <5 meters depth	10 meters	208	180	190
36-inch diameter steel pipe piles	Impact	On land	10 meters	201	174	186
36-inch diameter steel pipe piles	Impact	On land	20 meters	198	171	183
36-inch diameter steel pipe pile	Vibratory	In water, ~ 5 meters	10 meters	180-185	170-175	170
24-inch AZ steel sheet pile	Vibratory	In water, ~15 meters	10 meters	175-182	160-165	160-165

Considering the scenario which will be most acutely harmful during construction installation (36-inch diameter steel pipe piles in less than 5 meters water depth, impact pile driving in water, 5,000 strikes a day, no attenuation) with the production of 208-210 dB peak/180-190 dB SEL/177-190 dB RMS underwater sounds, the NMFS Pile Driving Calculator (NMFS 2008) indicates that the distance threshold within which instantaneous mortality would be expected to occur is 18 meters or less from the driven pile. For fish weighing more than 2 grams, the distance at which injury is expected to occur due to cumulative SEL exposure above 187 dB is within 1,585 meters from the driven pile (Table 11). The distance within which behavioral changes are expected is 4,642 meters from the driven pile, where the RMS sound will be above 150 dB RMS. SELs below 150 dB are assumed to not accumulate and cause fish injury, or be significantly different from ambient conditions, (i.e., effective quiet). At 5,000 strikes per day injurious cumulative SELs covers almost the entirety of the affected area, approximately 4,634 meters from the driven pile.

Pressure levels in excess of 150 dB RMS are expected to cause temporary behavioral changes (startle and stress) that could decrease a fish's ability to avoid predators or delay normal migration past the work site. The background RMS sound pressure levels, or effective quiet, is assumed to be 150 dB RMS and the acoustic impact area is the area where the predicted RMS sound pressure level generated by pile driving exceeds this threshold. Once the pressure waves attenuate below this level, fish are assumed to no longer be adversely affected by pile driving sounds. With effective quiet being equal to 150 dB RMS, the distance fish are expected to be adversely affected during pile driving is out to 4,642 meters from the location of the pile being driven, assuming a transmission loss constant of 15 (NMFS 2008). This distance effectively covered the width of the San Joaquin River bank to bank, the San Joaquin River being approximately 250 meters in width in this section, and would be expected to propagate 2.88 miles both up and downstream from the pile driving location.

Table 11. Threshold distances to in-water adverse effects using unattenuated maximum expected underwater sound (210 dB peak, 190 dB SEL, 190 dB RMS) modulated by strikes per day, when fish weight >2 grams, calculated by the NMFS pile driving calculator (NMFS 2008).

Strikes per Day	**Peak (dB) ≥ 206**	**Cumulative SEL (dB) ≥187**	**RMS (dB) ≥150**
5,000	18 meters	4,634 meters	4,642 meters

The underwater sound conditions in Table 11 would be expected to occur on days when in-water impact pile driving of 36-inch diameter piles occur (i.e., during the installation of the dolphins and fender piles), and represent unattenuated underwater sound monitoring data.

The total number of days over which fish are expected to be exposed to underwater sounds above effective quiet is expected to be approximately 93 days in Year 4 and 93 days in Year 5 (186 days total). The proposed in-water work window is effective in avoiding most interactions with CV spring-run Chinook salmon, because their upstream adult migration concludes by the end of June (summer water temperatures often exceed their lethality threshold at this location). However, CCV steelhead adults can begin their upstream migration in the fall through spring, and sDPS green sturgeon may remain in freshwater systems feeding and rearing throughout the year. It is possible that adult CCV steelhead may use the action area as a migration corridor, while sDPS green sturgeon adults and juveniles may use the action area as foraging and rearing habitat during the in-water work window, whenever water temperatures are suitable (at least below 75°F). According to in-river monitoring data available on the California Data Exchange Center for the San Joaquin River at Garwood Bridge station, water temperatures upstream of the action area in the San Joaquin River are likely to exceed anadromous fish (CCV steelhead, CV spring-run Chinook, and sDPS green sturgeon) thermal limits regularly during the work window. Water temperatures are likely to drop in September, with atmospheric temperature drops and increased cloud cover and rainfall. In some years, water temperatures may be tolerable to anadromous fish use throughout the summer, as seen in 2011 and 2017. Therefore, CCV steelhead and sDPS green sturgeon are assumed to be present when local water temperatures are below 75°F, though the total number of individual fish using the area during the work window is expected to be low.

Impact pile driving is expected to immediately injure or kill fishes within certain distance thresholds, depending on the size of pile being driven, the number of strikes used in a day, and whether attenuation measures are being employed. Using the greatest numbers of strikes estimated to drive the largest piles (up to 5,000), it is expected that fish ≥2 grams may be killed within nine meters (with underwater sound control) to 18 meters (without underwater sound control) of the driven pile due to in-water impact pile driving. In the same scenario, it is expected that fish ≥ 2 grams may be injured within 736 meters (with underwater sound control) to 4,634 meters (without underwater sound control, Table 11) of the driven pile due to the cumulative SELs produced by in-water impact pile driving. Because in-water impact pile driving is limited to the July through October in-water work window, CCV steelhead and sDPS green sturgeon are expected to be affected. CV spring-run Chinook salmon are not expected to be present in the action area July through October.

Vibratory Pile Driving July 1- July 14 and October 16 - November 30

Both flat sheet and pipe piles will be subject to vibratory driving, throughout a proposed extended in-water construction period. Vibratory pile driving is generally not immediately injurious to fishes even when performed in water without attenuation, it is likely that the underwater pressure waves and sounds will disturb the normal behaviors of fish using this area (Table 12), including potentially interrupting migration patterns and foraging activities, even while using underwater sound control measures.

Table 12. Expected maximum unattenuated hydroacoustic on 36-inch pipe piles and 24-inch sheet piles from vibratory pile driving, empirical data from the 2012 FHWG pile driving compendium Caltrans (Caltrans 2012).

Pile Type	Driver Type	Pile Location	Reference Distance	Peak (dB)	SEL (dB)	RMS (dB)
36-inch diameter steel pipe pile	Vibratory	In water, ~ 5 meters	10 meters	180-185	170-175	170
24-inch AZ steel sheet pile	Vibratory	In water, ~15 meters	10 meters	175-182	160-165	160-165

Flat Sheet Piles

Based on underwater noise levels measured during the TPP (ECORP 2019) and Year 1 (ECORP 2020), underwater noise levels are not anticipated to exceed NMFS criteria or impacts to listed anadromous fish. Unattenuated vibratory driving of two sheet piles during the TPP resulted in instantaneous peak underwater noise levels ranging from 174.3 to 193.9 dB (at 10m from the source) (Table 13), which was substantially lower than the 206 dB (at 18m from the source) peak threshold specified in NMFS' 2019 biological opinion. RMS values for unattenuated vibratory driving of the two sheets during the TPP ranged from 167.7 to 182.3 dB (at 10m from the source). RMS values did not exceed 150 dB beyond 1,423 m from the pile-driving activity.

Table 13. (Table 1 from BA 2021). Underwater peak and RMS noise levels for unattenuated pile-driving events and distance to NMFS 2019 BO thresholds under the 2019 TPP and Year 1 of construction.

Table 1. Underwater peak and RMS noise levels for unattenuated pile-driving events and distance to NMFS 2019 BO thresholds under the 2019 TPP and Year One (2020) of construction.

Year	Count	Pile Types	Noise Level (dB re: 1µPa)[1]				Distance to Threshold (m)			
			Peak		RMS		Peak		RMS	
			Range	Average	Range	Average	Range	Average	Range	Average
2019 TPP	2	Flat	174.3 to 193.9	184.1	167.7 to 182.3	179.2	0 to 2	1	151 to 1,423	787
2020 Year One	193	Z- and H-piles	139.6 to 190.2	164.0	110.3 to 179.1	149.9	0.0 to 1.6	0.3	0.0 to 1,574	36.5

[1] Values calculated for 10 m from the pile.

Additional information was collected on underwater noise levels in Year 2 (2021) at the project. The highest instantaneous peak values measured during vibratory driving in 2021 was 190.2 dB. The calculated maximum distance to compliance associated with the maximum peak value was 1.8 m. During the first two weeks of July 2021 and October 16-November 30, 2021, maximum instantaneous peak values did not exceed 176 dB and all measurements were in compliance with the 206 dB threshold within 0.2 m of the installed piles. According to these project-specific data, peak underwater noise levels did not exceed 206 dB beyond 1.8 m and below the 18 m threshold. As such, no ESA-listed fish were likely exposed to potentially injurious or lethal underwater noise levels from vibratory pile driving during the in-water work window, unless within ≤ 2 m of the piles.

Extended exposure to elevated RMS values above 150 dB may cause behavioral effects in fish, including avoidance and potential delays in migration. Data recorded in Year 2 indicated that vibratory pile driving of flat sheets did not exceed 113.4 dB (at 10 m from the pile) as an overall daily average for July 1-November 30 and were always below 150 dB RMS within less than 1 m from the pile being driven and typically did not exceed 150 dB RMS at any distance from the source. As such, vibratory pile driving of flat sheet piles is not anticipated to exceed the 150 dB RMS behavioral threshold beyond 1 m from the pile being driven during the in-water work period window.

Pipe Piles

For vibratory driving of the 36-inch round pipe piles, the peak and RMS values are anticipated to be higher than those measured for flat sheets. However, because vibratory driving propagates lower peak and RMS values than impact driving, vibratory driving of the pipe piles is anticipated to be within compliance with the peak (i.e., 206 dB at 18 m) and RMS (i.e., 150 dB at 2,154) at all times and likely within compliance with the peak and RMS thresholds within 10 m. Moreover, given the 175 m to 300 m width of the San Joaquin River at the south and north ends, respectively, of the floodwall, and the short distance to compliance with peak and RMS thresholds (i.e., typically less than 10 m), ESA-listed fish migrating through or foraging in the action area have an adequate zone of passage in which underwater noise levels are below the peak and RMS thresholds.

Based on these values, vibratory pile-driving noise is not anticipated to reach peak levels that would injure or kill ESA-listed anadromous fishes during the July 1-14 and October 16-November 30 extended construction windows in Year 4 (2023) or Year 5 (2024). While instantaneous peak underwater levels may be exceeded within less than 10 m from the source, anadromous fish are not anticipated likely to come within that close to an active pile-driving site due to the presence of equipment, personnel, and the turbidity curtain. RMS values that could cause behavioral effects (e.g., avoidance) would typically occur within 10 m of the vibratory pile-driver and is not anticipated to exceed 150 dB at 2,154 m from the source at any time. Historical temperature data indicates San Joaquin River temperatures in the action area are generally above 75°F during this period, above the preferred temperatures for anadromous fishes. Based on these considerations, extending the proposed period for vibratory pile driving in the Year 4 (2023) and Year 5 (2024) in-water work windows is unlikely to increase impacts on ESA-listed anadromous fishes. The primary impact from extending the in-water work window for vibratory pile driving would result in behavioral changes to an unknown number (likely a small number) of migrating adult ESA-listed salmonids and foraging green sturgeon.

Acoustic Effects of Barge and Boat Traffic

Barge and tugboat traffic will create additional sources of noise in the aquatic environment. This would be an acoustic-related stressor that could result in negative impacts to listed species present. Ships under power produce a substantial amount of mechanical- and flow-induced noise from motor, propeller, and hull turbulence. Measurements of sound intensity from commercial shipping have shown sound levels up to approximately 180 dB (ref. 1 μPa) at the point source (1 meter from ship) (Kipple and Gabriele 2007). This level of noise will drop off by 40 dB at 100 yards away and approximately 53 dB lower at one quarter mile (Kipple and Gabriele 2007). The narrow confines of channels in the action area indicate elevated noise levels generated by the passage of vessels, such as tugboats, would extend from bank to bank in the San Joaquin River. This noise would subject all fish within the confines of the channel to anthropogenic-produced noise conditions. The relatively rapid passage of the barge and tugboat past a given point will somewhat attenuate these effects by decreasing the duration of the elevated sound levels, but some temporary effects can be anticipated to occur, depending on the proximity of the exposed fish to the sound source. The presence of underwater noise, such as that originating with shipping, may adversely affect a fish's ability to detect predators, locate prey, or sense their surrounding acoustic environment (Slabbekoorn et al. 2010, Radford et al. 2014). Other species of fish have been shown to respond to recorded ambient shipping noise by either reacting more slowly to predators, thus increasing their susceptibility to predation (Simpson et al. 2015, Simpson et al. 2016), or becoming hyper-alert and reacting more quickly to a visual predator stimulus, causing them to cease feeding and hide (Voellmy et al. 2014b). Voellmy et al. (2014a) states that elevated sound levels could affect foraging behavior in three main ways: noise acting as a stressor, decreasing feeding behavior in the short-term through reduced appetite, or in the long-term through a reduction in activity and locomotion and alterations to the cognitive processes involved in food detection, classification, and decision making; noise acting as a distracting stimulus, diverting an individual's limited amount of attention from their primary task to the noise stimuli that have been added to the environment; noise masking crucial acoustic cues such as those made by both prey and predators.

Fish also may exhibit noise-induced avoidance behavior that causes them to move into less suitable habitat for foraging or will wait to feed when the noise has abated. Voellmy et al. (2014a) surmised that sustained decreases in food consumption could have long-term energetic impacts that result in reductions in growth, survival, and breeding success. Moreover, compensatory feeding activities could increase predation risks by increasing time exposed to predators or by forcing animals to feed in less favorable conditions, such as in times or areas of higher predation pressure.

Increased noise, produced by barge and tugboat traffic may result in salmonids and green sturgeon fleeing the area of those noises and moving into the channel's shallowest margins or adjacent habitat. The channel margins of many Delta waterways have submerged and emergent vegetation (e.g., Egeria) and rock rip-rapped levees where predatory species are likely to occur in greater numbers than in the open waters of the channel. This scenario therefore could increase the predation risk of salmonids, particularly smolts. Likewise, elevated noise exposure can reduce the ability of fish to detect piscine predators, either by reducing the sensitivity of the auditory response in the exposed fish or masking the noise of an approaching predator. Such would be the case if open water predators such as striped bass (*Morone saxatilis*) encounter the juvenile fish in the open channel while a barge and tug are present.

The following assessment further evaluates the proposed project-related incremental increase in boat traffic during the year-round in-water work window, including the June 15-30 staging period, and December 1-15 demobilization period.

Boat and barge traffic is anticipated to include two relatively short periods of daily barge movements (i.e., approximately 15 minutes per trip totaling 30 minutes per day) to travel 1.26 nautical miles each way to and from the staging area. This daily period of boat and barge traffic amounts to 3 hours per week (i.e., less than 1.8% of a 7-day period) during daylight hours. Based on these data, noise and disturbance associated with the Project-related boat and barge traffic is not expected to reach levels that would cause measurable behavioral effects, injury, or lethality to ESA-listed anadromous fishes during Year 4 (2023) and Year 5 (2024).

The small boats would be used for short durations (i.e., typically 10 minutes or less at time), primarily for shuttling personnel and equipment over short distances from the boat launch to the barge, relocating the underwater noise monitoring equipment, or for water quality and biological monitoring (i.e., typically 3-4 times per day). These boats would be used primarily within the mouth of the canal and, most often, in the 1,800-foot channel between the boat ramp and the active construction area and within approximately 300 feet of the active construction area. Trips into the San Joaquin River (e.g., to inspect for the presence of marine mammals, when necessary) would be infrequent, of short duration (i.e., typically ≤ 15 minutes), and usually limited to within a few hundred feet of the mouth of Smith Canal.

The larger tugboat used to move the barge would be used less frequently and primarily for repositioning or deploying the barge during different phases of construction. After deployment of the barge on or around June 15, this would be done on a semi-daily basis (i.e., typically a few times per week at most) and the duration of each movement would be relatively short (i.e., typically <30 minutes per barge movement). Movement of the barge would be primarily confined to within the mouth of Smith Canal, although there may be infrequent occasions that the tugboat would use the San Joaquin River mainstem to move or deploy a barge.

A tugboat will be used to move the construction barge(s) into position at the mouth of Smith Canal and, occasionally, to reposition the barge to complete work within the cofferdam and along the alignment of the gate. Upon deployment, the frequency and duration of the tugboat and barge movements will vary and will occur on an as-needed basis to position the barge and construction equipment at the appropriate location and orientation to complete the necessary tasks for different phases of the Project. As discussed above, this will typically be a semi-daily basis (e.g., several times per week) and each movement is anticipated to be relatively short (e.g., less than 30 minutes each). The tugboat motor will be turned off (i.e., silent) when not in use.

There are few reported values of underwater noise levels associated with tugboats in the scientific literature, as the majority of reported values for marine vessels pertain to large, commercial ships. However, Richardson et al. (1995) reported tugboat values of 172 dB RMS and 175 dB peak values for tugboats at 1 m from the source. The Xodus Group (2015) calculated a 16 m radius of potential fish disturbance (i.e., noise levels above 150 dB RMS) associated with tugboats. In a study comparing the noise levels associated with different marine ship classes, Veirs et al. (2016) reported source levels (SL) of 166-170 dB and received signal levels (RL) of just 108 dB for tugboats traveling at approximately 8 knots (9.2 mph). In all cases, these underwater noise values are associated with tugboats in transit (i.e., travelling at speeds greater than 5 mph) and thus are considered conservative for assessing the Project's use of the tugboat (i.e., to move a relatively small construction barge a short distance within the mouth of Smith Canal).

From data recorded during tugboat movements and underwater sound levels generated by tugboats in the available literature, the use of a tugboat outside the construction window is not anticipated to create underwater noise levels above 180 dB. Rather, the noise levels associated with the tugboat for the Project are anticipated to be below threshold values for injury to fish within a short distance (i.e., 16m) of the tugboat. To further minimize the potential for any impacts, the tugboat will obey the posted speed limit of 5 mph within the canal, use of the tugboat will be limited to the minimum amount necessary to complete the Project work, and the tugboat motor will be turned off when not in use. A fisheries biologist will be on-site during barge movements to monitor for erratically behaving fish in the Project area.

Boating activity will occur year-round but the primary boating activity that will occur during the extended in-water work window, (June 15-30 staging period, and December 1-15 demobilization period) will consist of the use of small (i.e., <30 feet) boats with outboard motors. These boats will be used primarily to shuttle construction personnel, supplies, and small equipment to and from the barge and active construction area for observation of construction activities and to conduct biological and water quality monitoring required in the Project's permits. Other uses of small boats may include monitoring of underwater noise, biological monitoring (e.g., presence of marine mammals), and water quality monitoring. These boats will primarily be running only during short periods throughout the work day, while transporting personnel and supplies to and from the dock (i.e., approximately 1,800 feet from the construction site) and movements will primarily be confined to within the mouth of Smith Canal and the boat ramp. This area of the lower San Joaquin River is a popular recreation boating and angling area. As such, the incremental increase in Project-related boat traffic to the overall boating activity in the Action Area will be minor and localized to within a channel that primarily serves as recreational boating access to the San Joaquin River.

Underwater noise levels generated from water vessels are affected by, and generally increase, with increasing boat size, speed, and revolutions per minute (RPM) of the boat propeller (Kipple and Gabriele 2007; Matzner et al. 2010). Kipple and Gabriele (2007) reported that small (i.e., up to 20 feet in length) recreational boats traveling at 10 knots (11.5 mph) had peak SPL values ranging from 157-172 dB re 1 µPa at 1 yard. This range of values equates to peak SPL values of 136-151 dB re 1 µPa at 10 m. RMS values associated with these SPLs would be considerably lower and would be less than, the "effective quiet" value of 150 dB. In a study of underwater noise associated with coastal boat traffic in North Carolina, Haviland- Howell et al. (2007) reported that small outboard motorboats comprised the highest percentage of boat traffic and had a maximum RMS value of approximately 71 dB re 1 µPa. Matzner et al. (2010) evaluated the underwater noise levels generated by small vessels equipped with one and two outboard motors, each with 3-blade and 4-blade propellers, at RPMs ranging from 2,000 to 6,000. The highest observed broadband noise level was 45 dB over background noise with the dual-engine boat at 6,000 RPMs, whereas the broadband noise was increased by only 15 dB for the single-engine boat at 2,000 RPMs. Notably, the SPL values for the single-engine boat at 2,000 RPMs were between 90-100 dB (Matzner et al. (2010). Barlett and Wilson (2002) reported that small boats operating at 2,600-6,000 RPMs had peak underwater noise levels of 150-165 dB. The SPL and peak values reported in these studies were below the thresholds for protection of fish. Furthermore, the boats used for the Project will typically be operating at well below 2,000 RPMs and, therefore, are anticipated to have even lower underwater noise levels.

According to these considerations, the use of small boats, tugboats, and barges during the in-water work window and outside the in-water work window is not anticipated to reach underwater noise levels that would exceed NMFS criteria. While the incremental increase in the use of small boats outside the construction window is not anticipated to increase underwater noise levels by an amount that would exceed the thresholds for injury to fish, any potential impacts will be further minimized by limiting all project boats to the posted 5 mph speed limit in the canal at all times, limiting boat traffic to the minimum amount necessary to complete the project work, and turning boat motors off when not in use. Furthermore, adverse impacts to ESA-listed fish from barge and boat traffic is not expected to occur.

2.5.1.3. RSP Placement

There will be placement of 0.386-acre of 18-inch RSP around the gate structure. The RSP would prevent scour of the gate foundation. Gate RSP placement is expected to occur in the later portion of the Year 5 (2024) in-water work window.

ESA-listed fish that have the potential to be present during the placement of Gate RSP include adult CCV steelhead and adult and juvenile sDPS green sturgeon. However, the timing of the placement of Gate RSP during the in-water work window (during July-September) coincides with the period when CCV steelhead are least likely to be present due to their migration timing and generally unsuitable habitat conditions. Adult and juvenile sDPS green sturgeon have the potential to be present, however background water quality in the action area is poor (low dissolved oxygen, low flow, high water temperatures), therefore the likelihood of green sturgeon being present during the placement of Gate RSP is very low.

ESA-listed fish have potential exposure to injury and mortality during the placement of Gate RSP through coming in contact with RSP during placement or with heavy machinery during placement. Gate RSP would be placed around the gate foundation by being lowered by excavators or clamshell buckets, which fish could come in contact with and potentially be injured or killed. However, the presence of equipment and personnel and associated disturbances are likely to cause most fish to avoid the immediate work area. RSP will be lowered slowly by the excavators/crane, allowing for fish to avoid/leave the work area. Furthermore, the presence of turbidity curtains around the active work area will further minimize the likelihood of fish entering the active work area. Gate RSP placement is expected to take no more than two weeks and is scheduled to occur during July-September of the extended in-water work window. Therefore, the exposure will be limited to this two-week period. A qualified fisheries biologist with work-stop authority will be present during the placement of Gate RSP and will halt construction if ESA-listed fishes are observed within or near the work area. Gate RSP placement would only occur during the daylight hours.

2.5.1.4. Cone Penetration Tests (CPTs)

SJAFCA proposes to complete approximately 13 Cone Penetration Tests (CPTs) (twelve in-water and one on land) near the floodwall and seepage cutoff wall alignments (on Dad's Point) to characterize the geological composition of the Project area. No impact or vibratory hammer would be used. Six CPTs will be performed on the San Joaquin River side of the floodwall, another six will be performed on the Atherton Cove/Smith Canal side of the floodwall, and one CPT on land on Dad's Point. Following CPTs, the work area is anticipated return to pre-Project conditions. CPTs are proposed for completion at the first part of the extended 2023 in-water work window (i.e., within the first two weeks of July).

Potential adverse effects of the CPTs to ESA-listed fish would be limited to the temporary voids resulting from boring into the substrate with hollow tubes. Each bore hole would create an approximately 3-inch diameter hole in the substrate at each location that would be filled with a grout material. Due to the fine, uncompacted sediments in the project area, the bore holes are anticipated to fill within one or two days. Water quality monitoring, including turbidity and pH monitoring associated with the five CPTs in 2019 did not detected changes in baseline conditions for either parameter.

CPT work would be conducted under the supervision of one or more qualified fisheries biologists with work-stop authority to ensure that no fish are injured, killed, or exhibiting signs of distress in response to the CPT work. The CPTs would be performed in the first two weeks of the requested in-water work window extension in Year 4 (2023) at a time when ESA-listed anadromous fish presence is anticipated to be very low due to their migration timing and elevated water temperatures. Therefore, the potential for ESA-listed anadromous fish to be directly injured or killed during the CPT work is also very low. Water quality measurements for CPTs in 2019 failed to detect changes in water quality parameters over baseline conditions.

Because similar methods would be used for the proposed 12 in-water CPTs, it is likely that these tests will also have minimal impacts to water quality. Adverse impacts from the CPTs to CV spring-run Chinook salmon, CCV steelhead, sDPS green sturgeon are not expected to occur.

2.5.1.5. Effects of Structures

Placement of riprap in the San Joaquin River can result in adverse effects to ESA-listed fish. The action area is a major migratory corridor for juvenile and adult listed fish. The finalization of the permanent floodwall gate would not impede fish passage, but it would occupy a portion of the area adjacent to the San Joaquin River. The action area currently does not provide suitable aquatic riparian habitat, but the modification and placement of riprap would preclude, in its footprint, any potential for future riparian vegetation to grow that would provide shelter and resting areas for migrating juveniles. The intent of riprap is to stabilize stream channels and limit natural fluvial processes. The reduction of the erosion and consequent deposition cycle, naturally inherent to all alluvial channels, eliminates a channel's ability to maintain bedforms for salmonid habitat and impairs the ability for a stream to be maintained in a dynamic steady state. This alteration of the aquatic ecosystem has diverse deleterious effects on aquatic communities, ranging from carbon cycling to altering salmonid population structures and fish assemblages (Schmetterling et al. 2001). Riprap does not provide the intricate habitat requirements for multiple age classes or species similar to natural banks, or banks that include instream woody material (Peters et al. 1998).

Therefore, adverse effects resulting from permanent habitat loss/modification to listed fish are expected to occur. Since it is not possible with the currently available information to determine how many individual fish will be taken through the loss or modification of the habitat, NMFS will use the values for lineal feet of aquatic habitat impacted and lost on waters bearing NMFS' listed species as ecological surrogates for the detrimental effects upon listed fish. This loss is expected to result in reduced fitness and survival of listed fish in the action area.

The proposed project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat. Additionally, 0.386-acre of 18-inch RSP material would be placed around the gate foundation. Once the fixed wall is constructed, approximately 3,400 tons of riprap (approximately 200 linear feet) would be placed along the banks at the Stockton Golf and Country Club (approximately 100 linear feet on each side of the fixed wall), as well as 230 linear feet around the tip of Dad's Point. The fixed gate wall would extend approximately 800 feet from the north tip of Dad's Point Levee to the right bank of the San Joaquin River, at the Stockton Golf and Country Club. The walls would be constructed to be between approximately 29 feet apart at the connection between cells and 34 feet apart at the widest part of each cell, and would have a top elevation of 15.0 feet, extending 10 feet above the mean water level at the entrance to Smith Canal.

2.5.1.6. Long-term Operations and Maintenance

The now existing gate is a 50-feet wide mitered double-door metal structure that when open extends outward into the San Joaquin River. The purpose of the gate when closed is to provide a tool for flood control when the San Joaquin River reaches a water surface elevation of 8.0 feet, North American Vertical Datum of 1988 [NAVD88]. Isolating Smith Canal and the 15,000 residents identified in a designated FEMA 100-year floodplain, will meet the Central Valley Flood Protection Act of 2008 which requires a 200-year flood protection by 2025 for urban and urbanizing areas.

Typically, the gates would be operated (closed) under specific conditions during the rainy season and during times when high tides occur in the area. Generally, extreme high tides and floods associated with the rainy season occur between November 1 and April 30. The gate will typically be operated only during extreme high tides and flood events when the water elevation exceeds + 8.0 feet (NAVD 88) in the channels containing the gates, or when operated for maintenance purposes. When operated for forecasted high tides above +8.0 feet, the gates would be closed on the lowest tide prior to the predicted high tide, typically within a 24-hour period. The gates would not be opened until the high tide elevation drops below +8.0 feet, allowing any accumulated water behind the gate to flow out. The Corps predicts that the duration of the gate closures for extreme high tides should not last more than 6 to 12 hours per a high tide event. Rarely will two extreme tides occur within a 24-hour period. On these infrequent occasions, the gates may remain closed for more than 24 hours.

The gate is controlled by programmable preset operating controls housed in a fixed building on Dad's Point adjacent to the fixed wall tie-in. A second set of controls may be installed at the end of the sheet pile wall near the shore and a portable generator will be used in the event of a power outage. During the long-term period of gate operations, the narrow gate opening (~50 feet) will create higher velocity flow through the structure than currently exists through the undeveloped channel during each tidal cycle. NMFS expects that elevated turbidities will occur in association with this higher velocity until the surrounding channel substrate has come to an equilibrium between heavier and coarser sediments lining the scour hole and the redistribution of the lighter material more prone to resuspension into other areas of the channel. It is unknown how long this process will take, and what level of turbidity is likely to occur as a result.

Additionally, NMFS expects that the presence of the flood gate structures would create altered flow conditions related to the narrow width of the flood control structure gates. This could increase predation upon listed fish species. These conditions would be present throughout the year and are created by daily tidal flows. A portion of all listed species identified above would be exposed to the operations of the Smith Canal flood control structure. Listed fish would have an elevated vulnerability to predation due to the hydrodynamic conditions created by the open gate structures and the vertical sheet pile wall structure placed into the open water environment, both of which are expected to attract predators. Higher velocities create more turbulence, eddies, and disorientation to the fish caught in the high velocity jet, allowing them to become easier targets for predators.

Effects of turbidity on fish

Resuspension of contaminated sediments may have adverse effects upon salmonids or sDPS green sturgeon that encounter the sediment plume, even at low turbidity levels. Lipophilic compounds in the fine organic sediment, such as toxic PAHs, can be preferentially absorbed through the lipid membranes of the gill tissue, providing an avenue of exposure to salmonids or sDPS green sturgeon experiencing the sediment plume (Newcombe and Jensen 1996). Such exposures to PAHs have been linked with declines in the immune systems of exposed fish as well as damage to genetic material through formation of breaks or adducts on the DNA strands. Similarly, charged particles such as metals (*e.g.*, copper), may interfere with ion exchange channels on sensitive membrane structures like gills or olfactory rosettes. This reduces the sensitivity of fish to detect smells or chemical cues in their environment and may interfere with ion exchange metabolism across cellular membranes necessary for osmoregulation. Increases in ammonia from the sediment may create acutely toxic conditions for salmonids or sDPS green sturgeon present in the channel's margins.

An increase in flow velocity due to gate operations between November 1 and April 30 overlaps with species run timing and adds to the probability of potential exposure of listed salmonids and green sturgeon to effects of higher levels of turbidity. Therefore, we expect a small number of each species to be adversely affected each year, resulting in decreased fitness and survival.

Effects Related to Long Term Maintenance of RSP

The potential of injury/mortality to juvenile ESA-listed fish could also come from increased predation from bass and other predators who might use the interstitial spaces in the Gate RSP. These interstitial spaces would be filled with ≤ 6-inch rock to avoid creating potential fish predatory habitat in the RSP voids. The voids will further be filled in with fine sediments dominating the benthos in the mouth of the canal, further reducing the potential for predator refugia. This interstitial RSP will be placed in the same manner as the larger RSP. As a result of timing, avoidance behavior of ESA-listed fish, and measures to fill in voids, adverse impacts to ESA-listed fish from placement of RSP around the gate structure is not expected to occur.

Effects Related to Long Term Operations of the Flood Control Gates

Episodes of extreme tides create larger than normal movement of waters in the Delta and may stimulate adult fish holding in the Delta to move upstream to spawn. When the gates are operated, any fish moving with the increased tidal activity may enter the waterways behind the gates on prior tides and become trapped by the closed gates. However, fish trapped behind the closed gate would typically be detained for less than 24 hours, and usually only for 6 to 12 hours. Fish trapped behind the gate will have typically short-term exposures to the waters behind the gates, and any deleterious water quality issues or predator populations that may exist there. Any fish caught behind the gates cannot leave the area of degraded water quality until the gates are reopened, and thus are exposed to any negative conditions existing for the duration of the closure. The short duration of exposure is probably not sufficient to cause mortality from any contaminants that might be present, but sublethal effects may start to manifest even with exposures of only a few hours. Smith Canal, as well as several waterways draining to the eastern Delta in the action area, are listed under the EPA's 303(d) listing of impaired water bodies in California (State Water Resources Control Board 2010) containing elevated levels of organic materials, pesticides, heavy metals, and pathogens, as well as many other constituents that impair water quality. Furthermore, it is unclear how the physical barriers will affect the level of contaminants in the impacted waterways, but it is likely to degrade water quality over the long-term by preventing dilution and muting tidal exchange with the larger Delta. Finally, when fish are trapped behind the gates, they become susceptible to predators that may reside in the waterways behind the gate. Trapped fish will be exposed to these predators for the duration of the gate closure with a reduced avenue of escape through the narrow gate opening. Fish such as

CCV steelhead smolts and juvenile CV spring run Chinook salmon are highly vulnerable to predation by predators such as striped bass (*M. saxatilis*) or largemouth bass (*Micropterus salmoides*) that may also occupy the waters behind the gates.

Adult CV spring-run Chinook salmon and CCV steelhead are less likely to be preyed upon, unless marine mammals such as California sea lions (*Zalophys californianus*) also are present in the waterways when they are closed off. Sea lions are known to occur within the Stockton DWSC leading to the Port of Stockton and are likely to be present near the Smith Canal gates.

SJAFCA has indicated that if necessary the gates will be closed for an extended period during flood conditions particularly when they are coupled with high tides. If flood conditions, either by themselves or in combination with high tide events, raise the water elevation to greater than +8.0 feet NAVD 88, the gates will be closed until the water elevation recedes below +8.0 feet. Records show that the high water conditions may last several days. As indicated above, there is the potential for listed fish to be trapped behind the flood control gates when closed. Under flood conditions, the longer duration of gate closures will expose fish to longer periods of degraded water quality or predation within the enclosed water bodies. Furthermore, flood conditions usually coincide with increased precipitation events that create surface runoff from upland areas. This results in increased stormwater flows into waterbodies such as Smith Canal and the sloughs feeding into other waterways. Stormwater runoff has the potential to be heavily contaminated with organic materials (which decrease DO content in the water), petroleum products and heavy metals from roadways, pathogens, and pesticides. Stormwater is cited as a source for these contaminants in Smith Canal (State Water Resources Control Board 2010).

Elevated contaminant loads coupled with longer exposure periods will increase the likelihood of sublethal and lethal effects on exposed fish. Furthermore, increased durations of gate closure will expose any listed fish trapped behind the gates to longer periods of predation risk in those waters. Periods of high runoff that could trigger longer gate closures usually occur in the winter and spring seasons. This period overlaps with the migrations of adult and juvenile CCV steelhead in the San Joaquin River basin. Additionally, adult and juvenile CV spring-run Chinook salmon from the SJRRP nonessential experimental population and their future progeny would be migrating through the San Joaquin River adjacent to the Smith Canal flood control gates during the late winter and spring periods. There is also an increased potential for adult sDPS green sturgeon to begin movements upstream into the San Joaquin River in response to increased flows in the mainstem of the river and its tributaries. Movements of juvenile sDPS green sturgeon in the Delta may also be enhanced by increases in river flows and increased turbidity.

Any individual fish that is trapped behind the closed gates will be vulnerable to increased mortality with prolonged closures. In contrast, more frequent gate operations expose more individual fish to the effects of the flood control structure, but the duration of their captivity is shorter, and lethal effects are less likely to occur due to exposure to contaminants and predation. Although there is significant risk to any individual fish trapped behind the gates, the numbers at risk depends on the proportion of the population moving past the gates at the time the gates are closed and what fraction of that number is actually behind the gates when they are operated. This level of detail is hard to predict and is likely variable.

Risks to fish are not limited to being trapped behind the gates when they are closed. The construction of the flood control gates and the accompanying flood wall create a barrier to the free exchange of water into the Smith Canal waterway during the daily tidal cycle. The relatively narrow opening of the gates (50 feet) compared to the width of the unobstructed channel will create a region of high velocity flows through the gate openings with each tidal change in water surface elevation. This zone will be bi-directional as a result of the changes in tidal elevation; flow will move from the area of higher water elevation to the area of lower water elevation depending on the stage of the tide. On the flood tide, water elevations will be increasing on the outside of the gate structures relative to the inside of the gate structures and water will flow up-channel through the narrow gate opening into the area behind the gates at increasing velocity due to head differentials between the two sides of the gate structure. Flow through the gates will diminish as the two water elevations reach equilibrium at high tide. When the tide changes to ebb, the water inside the flood structure will be higher than the water elevation outside and remain so for a longer period of time due to the gate constriction and the flow will reverse direction.

Creation of a high velocity water flow through the gate opening will create a field of velocity shear causing eddies and turbulence on the down current side of the gate. This region of shear and turbulence provides favorable habitat for predators to hold and feed, as prey moves through the high velocity water flow. This is particularly true when the flood structure creates vertical structure for predators to orient to immediately adjacent to the higher velocity flow, and hold station outside the higher velocity flows without physically exerting themselves to remain in the favorable feeding locations. The structure also creates shade and obscures the presence of the predators holding against the vertical sheet pile wall, creating an increased risk of predation for smaller sized fish such as juvenile CV spring-run Chinook salmon and CCV steelhead smolts that are entrained in the fast moving stream of water going through the gate opening. This condition will occur typically four times a day with each change of the tide while the gates are open.

In addition to the creation of the high velocity flows through the gate openings and increased predation risks, the flood-gate structures also are likely to degrade water quality conditions inside the waterways when the gates are closed. Closed gates will reduce the free exchange of water within the waterways they block with the larger Delta system. This will reduce the volume of water exchanged on each tidal cycle with the larger Delta water volume and increase the residence time of the water behind the gate structures and flood wall. This situation is likely to allow contaminants behind the flood structure to increase in concentration since they are not being flushed out of the system as fast as the pre-gate conditions allowed.

In summary, the long-term operations of the flood control gates on Smith Canal will create barriers to the free movement of individual fish moving within close proximity to the gates and may cause fish to become entrained behind the closed gates. Listed fish that enter through the gate opening will be subject to increased predation risk and exposure to degraded water quality conditions. The gate structures will also create physical conditions that decrease the value of the habitat adjacent to these structures. Diminished circulation will decrease flushing flows through these waterbodies, potentially allowing any contaminants discharged into the waterbody behind the structures to increase in concentration and not be transported away from the confined waterbodies. The narrow gate opening will create hydraulic conditions that will favor predatory fish, which would be attracted to the open water structure created by the flood barrier. Both of these physical conditions would increase adverse effects to listed fish exposed to them. These conditions will be present at all water elevations to some extent as described above. Based on the best available information, we expect a small number of each species to be adversely affected each year, resulting in decreased fitness and survival.

2.5.1.7. Gate Warranty Testing and Repair

During the gate warranty period, SJAFCA will inspect the facilities for damage and/or deficiencies, and the contractor will remedy the damage and/or deficiencies. Warranty period inspections are planned to occur in 2024 and 2025, and repairs would occur in 2025 and, if needed, 2026. During testing and repair, the gate would remain open, stop logs would not be installed, and the gate structure would not be dewatered during inspection and repairs. Warranty testing would occur during the migration periods of adult CCV steelhead, and the Delta residence period of adult and juvenile sDPS green sturgeon. In-water construction activities not completed by the end of the 2024 in-water work window would be completed during the 2025 and 2026 in-water work windows. Because the activities to be implemented would be limited to visual observation by divers or camera-equipped ROVs, replacement of minor parts in-water and coating repairs above water, Gate Warranty Period activities are not anticipated to result to adverse impacts to ESA-listed fish species.

2.5.2. Project Effects on CCV steelhead and sDPS green sturgeon Critical Habitat

The project is expected to adversely impact several PBFs of critical habitat for CCV steelhead (freshwater rearing habitat and freshwater migration corridors) and sDPS green sturgeon (food resources, water quality, water depth, and migratory corridors). The proposed project is expected to cause short- and long-term, and permanent effects on critical habitat for CCV steelhead and sDPS green sturgeon. Potential project effects include temporary water quality degradation from localized increases in turbidity and suspended sediment from construction and gate operation, permanent habitat loss/modification of critical habitat from RSP placement and presence of the floodwall, and in-channel disturbance from pile driving. Long-term effects on designated critical habitat PBFs are expected to result in a decrease in survival of fish due to increased predation in the action area and impacts from the operations of the tidal gate, resulting in impacts to migratory corridor PBFs.

Poor water quality and elevated contaminant concentrations due to low water exchange rates can impact salmonid rearing habitat PBFs, particularly juveniles that rear in these waters year-round and consume prey exposed to the contaminants such as sDPS green sturgeon. Alternatively, PBFs for food resources may be diminished due to mortality related to the contaminants present or perhaps a combination of diminished prey populations with the remaining prey populations bearing contaminant loads that are then transferred to the green sturgeon that consume them. Green sturgeon that consume contaminated prey may incur sublethal or lethal effects depending on the load and type of contaminates consumed, thus resulting in degraded food resource PBFs.

Placement of the tidal gate will extend 800 linear feet from the tip of Dad’s Point levee to the right bank of the San Joaquin River. In addition, 200 linear feet of riprap will be placed on the banks of Stockton Golf and Country Club. Therefore, the project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat, resulting in degradation of rearing habitat PBFs.

Habitat in this portion of the San Joaquin River is characterized as a relatively deep, medium velocity channel, with silt and sand substrate. The action area does not include salmonid spawning habitat; however, migration and rearing habitat PBFs are utilized. Low numbers of adult and juvenile sDPS green sturgeon may also utilize food resources PBFs.

While the sandy substrate in the vicinity of the proposed project provides some submerged aquatic and emergent vegetation, it does not currently provide favorable rearing habitat PBFs for salmonids due to the lack of shaded aquatic habitat and habitat complexity. However, placement of permanent infrastructure would prevent improvements to provide more suitable habitat for listed species in the future. In addition, the placement of riprap for scour protection is expected to decrease habitat quality PBFs for salmonids, as warm-water predatory species (such as bass) would be likely to occupy this habitat post-construction.

Because the proposed project will occupy CCV steelhead and sDPS green sturgeon critical habitat, a purchase of compensatory mitigation credits is included as part of the proposed action associated with the rip rapping of the tide gate to partially offset this impact to PBFs. Placement of 0.386-acres of RSP around the tide gate was not included or analyzed in the two prior biological opinions. SJAFCA will purchase salmonid credits at a 3:1 ratio from a NMFS approved mitigation bank. SJAFCA will purchase 1.16 credits for the loss of 0.386 acres of tidal perennial habitat.

Purchase of compensatory mitigation credits will restore and preserve, in perpetuity, shaded riverine aquatic habitat or similar types of riverine habitat that will be beneficial to salmonids. The mitigation banks that serve the action area offer floodplain or other habitat that can support migrating juvenile and adult CCV steelhead and sDPS green sturgeon in the same way that river margin habitat otherwise would have, had the project not occurred. Shaded riverine habitat types of conservation credits can benefit both adult and juvenile CCV steelhead and sDPS green sturgeon, even if such banks are located far from the action area and individuals affected by the project would be unlikely to benefit from the compensation purchase.

The purchase of credits provides a high level of certainty that the benefits of a credit purchase will be realized because each of the NMFS-approved banks considered in this biological opinion have mechanisms in place to ensure credit values are met over time. Such mechanisms include legally-binding conservation easements, long-term management plans, detailed performance standards, credit release schedules that are based on meeting performance standards, monitoring plans and annual monitoring reporting to NMFS, non-wasting endowment funds that are used to manage and maintain the bank and habitat values in perpetuity, performance security requirements, a remedial action plan, and site inspections by NMFS. In addition, each bank has a detailed credit schedule, credit transactions, and credit availability that are tracked on the Regulatory In-lieu Fee and Bank Information Tracking System (RIBITS). RIBITS was developed by the Corps, with support from the Environmental Protection Agency, the USFWS, the Federal Highway Administration, and NMFS to provide better information on mitigation and conservation banking and in-lieu fee programs across the country. RIBITS allows users to access information on the types and numbers of mitigation and conservation bank and in-lieu fee program sites, associated documents, mitigation credit availability, service areas, as well as information on national and local policies and procedures that affect mitigation and conservation bank and in-lieu fee program development and operation. RIBITS also contains links to bank establishment documents. The Bullock Bend Mitigation Bank was established on June 23, 2016; the Cosumnes Floodplain Mitigation Bank was established on August 4, 2008; the Fremont Landing Conservation Bank was established on October 19, 2006; and the Liberty Island Conservation Bank was established on July 21, 2010.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02 and 402.17(a)). Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

The private and state activities described below are likely to adversely affect CV spring-run Chinook salmon, CCV steelhead, sDPS green sturgeon, and designated critical habitats for CCV steelhead and sDPS green sturgeon. These potential factors are ongoing and expected to continue into the future. However, the extent of the adverse effects from these activities is uncertain, and it is not possible to accurately predict the extent of the effects from these future non-Federal activities.

2.6.1. Agricultural Practices

Agricultural practices in the action area may adversely affect riparian habitats through upland modifications of the watershed that lead to increased siltation, reductions in water flow, or agricultural runoff. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which can flow into the receiving waters of the associated watersheds. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonids reproductive success and survival rates (Dubrovsky et al. 1998, Daughton 2003).

2.6.2. Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth would place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, would not require Federal permits and would not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization also is expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially would degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This in turn would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.6.3. Rock Revetment and Levee Repair Projects

Depending on the scope of the action, some non-federal riprap projects carried out by state or local agencies do not require federal permits. These types of actions as well as illegal placement of riprap occur within the watershed. The effects of such actions result in continued degradation, simplification, and fragmentation of riparian and freshwater habitat.

2.7. Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the proposed action. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the proposed action is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminish the value of designated or proposed critical habitat as a whole for the conservation of the species.

2.7.1. Summary Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016a) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review. Therefore, we concluded that CCV steelhead should remain listed as threatened, as the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Further, there is still a general lack of data on the status of wild steelhead populations. There are some encouraging signs, as several hatcheries in the Central Valley (such as Mokelumne River), have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percent of wild fish in those data remains much higher than at Chipps Island. Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San

Joaquin River Basin continue to show an overall very low abundance, and fluctuating return rates. The NMFS Recovery Plan (NMFS 2014) strategy for CCV steelhead lists the San Joaquin River's eastside tributaries (Stanislaus, Tuolumne, and Merced rivers) as Core 2 populations (meaning these watersheds have the potential to support viable populations, due to lower abundance, or amount and quality of habitat) downstream of major dams, and as candidates to reach viable population status if reintroduced upstream of the dams, and lists the San Joaquin River, downstream of Friant Dam, as a candidate to reach viable population status. The action area serves as a migratory corridor to these eastside tributaries.

2.7.2. Summary Status of the CV spring-run Chinook salmon

The CV spring-run Chinook salmon ESU is also listed as threatened under the ESA but, until recently were considered extirpated from the San Joaquin River Basin. The NMFS 2016 5-Year Status Review re-evaluated the status of CV spring-run Chinook salmon and concluded that the species should remain listed as threatened (NMFS 2016a). Through recovery plan implementation and SJRRP reintroduction efforts (SJRRP, 2018), reintroduced CV spring-run Chinook salmon are expected to use the action area. One of the primary reasons this species is listed under the ESA is the ubiquitous artificial modifications to, and destruction of, crucial freshwater habitat and the services it provides in the Central Valley (NMFS 2016a). This threat currently persists and is expected to grow as human populations, land development and freshwater demands increase in California. Such trends are likely to suppress the recovery potential of these populations, despite recovery efforts, based on the effective scale of adverse habitat changes compared to recovery actions. The NMFS Recovery Plan (NMFS 2014) indicated that for CV spring-run Chinook salmon, re-establishing two viable populations in the San Joaquin River Basin would be necessary for recovery. The action area is a migratory corridor to the upper reaches of the San Joaquin River and its tributaries, downstream of Friant Dam.

2.7.3. Summary Status of the sDPS green sturgeon

The federally listed sDPS green sturgeon and its designated critical habitat occur in the action area and may be affected by the proposed action. It was listed as threatened in 2006 and its designated critical habitat in 2009. Adult sDPS green sturgeon potentially migrate through the action area to reach upstream riverine habitat based on catches of sDPS green sturgeon in the San Joaquin River mainstem, upstream of the Delta (CDFW sturgeon report card data). Juvenile sDPS green sturgeon migrate toward seawater portions of natal estuaries as early as one and a half years old (Allen and Cech 2007). Juvenile and subadult sDPS green sturgeon may rear in freshwater and brackish water for up to three years in the Delta. During laboratory experiments, juvenile sDPS green sturgeon select low light habitats and are primarily inactive during daylight hours, while they seemed to forage actively during night (Kynard et al. 2005). Juvenile sDPS green sturgeon were captured over summer in shallow shoals (1-3 meters deep) in the lower San Joaquin River (Radtke 1966), and are assumed to occupy similar habitats in other Delta region waterways. There is a need for additional information regarding sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology. The upstream portion of the San Joaquin River is not known to currently host sDPS green sturgeon spawning; therefore, the San Joaquin River Basin is not a main focus of their recovery plan. Though the sDPS does use the lower San Joaquin River and the discovery of an individual adult in the Stanislaus River October 2017 highlights that passage for adults is possible during certain river conditions, the recovery plan and efforts are not likely to be modified unless adult spawning or juvenile reproduction occurs (NMFS, 2018).

2.7.4. Summary of the Environmental Baseline and Cumulative Effects

Listed salmonids currently use the action area as a migratory corridor. For CCV steelhead and CV spring-run Chinook, the San Joaquin migratory corridor is an essential component of the recovery strategy because it provides access to the tributaries of the southern Sierra-Nevada Diversity Group (NMFS 2014). The San Joaquin River Basin is not the main focus for sDPS green sturgeon recovery plan. Currently, the San Joaquin River, although degraded due to levees and lack of floodplain habitat, is an important migratory corridor for the recovery of these species.

The cumulative effects section of this biological opinion describes how continuing or future effects such as the discharge of point and non-point source chemical contaminants discharges and increased urbanization affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of migratory corridors.

2.7.5. Summary of Project Effects on ESA-listed species

1) Construction-related Effects

During construction, behavioral effects as well as injury or death to individual fish is expected to result from completion of the floodwall and gate structure which includes noise exposure from pile driving and boat/barge activities. Construction activities would occur during the summer and fall months, when the abundance of individual fish is low and outside of most of the migrating adult and juvenile timing period, which would result in correspondingly lower levels of injury or death, and behavioral effects. In addition, during construction activities, water quality impacts, including increased sediment and turbidity are expected to occur, but with the implementation of minimization measures, impacts would be minor to listed species, resulting in behavioral modifications such as displacement and reduced feeding.

2) Long-term Operations and Maintenance Effects

All species considered in this consultation would be present at some point in time when the Corps anticipates the gate would be operated to protect against high water events (November 1 through April 30). All species entrapped would be affected by degraded water quality behind the flood control gates in Smith Canal. As a result of operations and maintenance, NMFS expects that water quality would degrade overtime due to a decrease in tidal flushing of the Smith Canal waterway and an increase in the residence time of water behind the sheet pile walls due to the obstruction of the channel. Salmonids and sturgeon tend to be sensitive fish species to in response to impaired water quality conditions compared to other fish species, particularly non-native species (Waters 1995, Barret et al. 1992). It is uncertain what fraction of the listed fish populations would be present when the gates are operated, and of that fraction present, how many would be entrapped behind the gates. It is certain that those fish trapped behind the gates would be exposed to more highly degraded water quality conditions than those fish remaining outside the gates, and would likely have a higher risk of predation while remaining behind the gates. NMFS assumes that fish trapped behind the gates are likely to die in the enclosed area. The gate structure increases the risk to passing salmonids and green sturgeon above the current conditions and therefore should be considered as adversely affecting the populations of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon in the action area.

Gates will be operated for approximately 17 percent of the time in January and February when adults may be moving upriver to spawning grounds, leaving the gates open for 83 percent of the time. The majority of adults are expected to migrate upriver in December and January with the run tapering off quickly in February and March. The gate operations for tides overlaps with a significant proportion of the adult spawning run, however, there is low probability of CCV steelhead being attracted into Smith Canal due to a lack of any tributary inflow, although some false attraction may be created by the high velocity currents described above as a result of tidal elevation differentials. The duration of any entrapment for adults in response to tidal operations will typically be brief (usually lasting no more than 6 to 12 hours per a high tide event), and exposure to contaminants should not result in mortality. CCV steelhead smolts are not likely to be emigrating downriver at the time that gates are being operated for the high tides. Therefore, there is a low risk of smolts being entrapped behind the gates. Gate closures for high water events due to high inflows will result in an average of three closures per year, meaning that there are only that many gate closures to entrap adults or juveniles. While the fish trapped behind the gates for flood closures are likely to be lost to the population, there are no new fish being entrapped by gate operations on additional days while the gates remain closed.

Few CV spring-run Chinook salmon juveniles or smolts would be expected to be moving downstream at this time past the Smith Canal flood gate location, thus exposure to the tidal operations are limited. Some individuals may be present and subsequently entrapped by the operations of the gates and lost. The gates may be closed for approximately 12 percent of the operating season (3 weeks out of 25 weeks; November through April) but will only amount to three gate closures per year on average. Thus, there are only three events per year that will trap fish behind the gates. It is unlikely that these three closure events will overlap with a substantial proportion of the population being present at the gate when it is closed. While the gates are closed during high water events, juvenile and adult fish in the DWSC are unaffected by the presence of the gate structure.

The gates will be operated when both juvenile and adult sDPS green sturgeon may be present in the vicinity of the gate structure. Individual fish may be present in the DWSC and potentially on the flats in front of the gates and thus may become vulnerable to entrapment behind the gates when they are closed. Some of these individuals may be lost to the population. However, available information indicates that sDPS green sturgeon are present in low densities and numbers in this area of the Delta based on the low numbers of fish catches on the CDFW sturgeon report cards, compared to other areas of the Delta. The majority of reported sDPS green sturgeon catches in monitoring efforts and sport fishing catches indicate that sDPS green sturgeon utilize other areas of the Delta and Sacramento River watershed for their life history needs, rather than the DWSC in the Port of Stockton. Using the same reasoning as given for CV spring-run Chinook salmon and CCV steelhead, there is a low likelihood of trapping green sturgeon behind the gates due to the low frequency of gate closures overall, compared to the time they are open, and the low numbers of fish present.

2.7.6. Summary of Project Effects on CCV steelhead and sDPS green sturgeon critical habitat

Within the action area, the relevant PBFs of the designated critical habitats for listed CCV steelhead are migratory corridors and rearing habitat, and for sDPS green sturgeon the six PBFs include food resources, water flow, water quality, migratory corridors, water depth, and sediment quality. Several components of the proposed project are expected to result in adverse effects to the designated critical habitat in the action area for both CCV steelhead and sDPS green sturgeon. The temporary construction impacts to designated critical habitat would negatively affect the ability of CCV steelhead and sDPS green sturgeon to use the action area as rearing habitat and as migratory corridors during the overlap of migration periods and construction as discussed in the effects to species section. Construction effects would last for a period of weeks, but would not permanently modify critical habitat function as noise and turbidity would end after construction ends.

The impacts of the Smith Canal flood control gate operation would permanently create unsafe migration conditions when fish become trapped behind the gate. However, the flood control structure is not expected to substantially impede migration, as the periods of potential entrapment would only occur during closure of the gate for short-term operations (due to tidal fluctuations). Estimated closure would occur approximately two times per year during November through April, lasting between 6 to 12 hours. Taking the maximum closure time of 12 hours and a closure frequency of two times per year between November through April, the gates will be closed approximately 17 percent of the time during these periods. For flood events, the SJAFCA has estimated that the gates will be closed on average two times a year from a few days to a few weeks based on the past 20 years of hydrology records. If the gates are closed for three weeks every year for high water elevations due to tides and inflow, then the gates are closed approximately 12 percent of the time out of 25 weeks (November through April).

The project is expected to adversely impact several PBFs of critical habitat for CCV steelhead (freshwater rearing habitat and freshwater migration corridors) and sDPS green sturgeon (food resources, water quality, water depth, and migratory corridors). The placement of the tidal gate will extend 800 linear feet from the tip of Dad’s Point levee to the right bank of the San Joaquin River. In addition, 200 linear feet of riprap will be placed on the banks of Stockton Golf and Country Club. Therefore, the project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat. Additionally, 0.386-acre of RSP will be placed around the gate structure. The Gate RSP would include loss of physical habitat. Placement of permanent infrastructure and additional RPS around the gate would prevent improvements to provide more suitable habitat for ESA-listed species. In addition, the placement of riprap for scour protection is expected to decrease habitat quality for salmonids, as warm-water predatory species (such as bass) would be likely to occupy this habitat post-construction.

2.7.7. Mitigation Bank Credits

SJAFCA's mitigation credit purchase is expected to mitigate a portion of the impacts from the Smith Canal Gate project, by providing some benefits to the CCV steelhead DPS by improving riverine or floodplain habitat conditions elsewhere through restoration and ensuring their preservation into the future. The benefits offered to these populations are expected to exist in perpetuity. Although some of the banks that cover the action area in their service area may not technically offer sDPS green sturgeon credits, we expect that some sDPS green sturgeon individuals should benefit from the purchase of credits from these banks since individuals should be able to access the purchased riverine habitat areas created and maintained by the banks/programs.

2.7.8. Synthesis of Effects at the ESU/DPS and Critical Habitat Designation Levels

The flood control structure is not expected to substantially impede migration, as the periods of potential entrapment would only occur, on average, two times per year (usually lasting no more than 6 to 12 hours per a high tide event). The flood control structure is located along the opening of Smith Canal and set back from the San Joaquin River. The presence of the gate structure will continue into the foreseeable future, creating a perpetual source of poor water quality (when the gates are closed) and predation impacts to the action area, and a permanent adverse effect of the structure itself to rearing and migratory corridor habitat, and to the San Joaquin River populations of the listed species. However, the long-term effect of the structure itself is not expected to affect the other populations of the ESU or DPSs within the Sacramento River of CV spring-run Chinook salmon ESU, CCV steelhead DPS, and green sturgeon DPS populations and will not negatively affect their viability.

The number of fish present when the gates are closed, and subsequently trapped behind the gate, is unlikely to represent a substantial proportion of the population present in the system, thus impacts to the DPS/ESU are minimal. The low impact of the Smith Canal Gate to the CCV steelhead population in the San Joaquin River basin over the foreseeable future will not substantially affect the CCV steelhead DPS and will not negatively affect its viability. It is not expected that the operations of the Smith Canal flood control gates will have any demonstrable effect on other populations of CV spring-run Chinook salmon in the ESU. The low impact to the CV spring-run experimental population and its progeny over the foreseeable future will not substantially affect the CV spring-run Chinook salmon ESU and will not negatively affect its viability. The loss of the few individual fish trapped behind the gate when it is closed will not substantially affect the green sturgeon DPS in the Central Valley and is not expected to impair its viability.

Combining the adverse and beneficial effects (compensatory mitigation) associated with the proposed action described above, environmental baseline, cumulative effects, and status of the species and critical habitat, the project is not expected to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing their numbers, reproduction, or distribution; or appreciably diminish the value of designated critical habitat for the conservation of the species.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the Proposed Action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon, and is not likely to destroy or adversely modify designated critical habitat for CCV steelhead and sDPS green sturgeon.

2.9. Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1. Amount or Extent of Take

NMFS cannot, using the best available information, quantify and track the amount or number of individuals that are expected to be incidentally taken per species because of the variability and uncertainty associated with the population sizes of the species, annual variation in the timing of migration, and variability regarding individual habitat use of the action area. However, it is possible to express the extent of incidental take in terms of ecological surrogates for those elements of the proposed action that are expected to result in incidental take.

These ecological surrogates are measurable, and the Corps and SJAFCA can monitor the ecological surrogates to determine whether the level of anticipated incidental take described in this incidental take statement is exceeded.

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows: increases in turbidity, pile driving, barge and boat traffic noise, operations and maintenance, and permanent loss of habitat.

2.9.1.1. Incidental take associated with water quality (elevated in-river turbidity plumes and disturbance)

- ***Construction-related increased turbidity*** – The ecological surrogate for turbidity increase (in NTU) is equal to or less than 50 NTUs higher within 1000-feet of the disturbance activity when compared to the NTU background levels measured upstream of the project.

NMFS expects that during the in-water work window of July 15 through November 30 (for 2023 and 2024 season) and mid-July through mid-October (for 2025 and 2026 season), there would be adverse effects from increased turbidity as a result of the project to listed species present. NMFS expects the following species and life stages to be present during the in-water work window:

- Adult CCV steelhead
- Adult and juvenile sDPS green sturgeon

The most appropriate threshold for incidental take consisting of fish disturbance and sub-lethal effects associated with elevated in-river turbidity plumes is an ecological surrogate of the amount of increase in downstream in-river turbidity generated by dredging, riprap, or pile driving related activities. In-river pile driving, dredging, and riprap placement are expected to mobilize sediment and increase water turbidity beyond natural levels to some degree. Increased turbidity is expected to cause harm to listed species present through elevated stress levels and disruption of normal habitat use. These temporary responses are linked to decreased growth, survivorship, and overall reduced fitness as described in the effects section for underwater noise avoidance.

The ecological surrogate for turbidity increase is based on salmonids sensitivity to raised turbidity levels. Typical background turbidity in the San Joaquin River during the in-water work season is approximately 25 to 80 NTU (CDEC 2018). Fifty NTUs is above the range at which salmonids experience reduced growth rates but below the range, salmonids would be expected to actively avoid the area. Therefore, the surrogate for incidental take associated with turbidity increase is 50 NTUs higher than NTU background levels measured upstream of the project. Turbidity would be measured immediately downstream of the boundary already established for the action area and construction noise/pile driving disturbance surrogate (1000 feet in the San Joaquin River waterway from the northernmost boundary of the construction footprint) (SJAFCA 2018). Within 1000-foot, the San Joaquin River water is expected to increase up to 50 NTUs above the turbidity level in upstream measurements. Exceeding 50 NTUs will be considered as exceeding the expected incidental take levels.

2.9.1.2. Incidental take associated with pile driving

- ***Pile Driving*** – The ecological surrogate for piling driving is 150dB RMS behavioral threshold up to 2,154 meters from the pile, 187 dB cumulative SEL threshold up to 1597 meters from the pile, and peak 206 dB threshold up to 18 meters from the pile.

During pile driving, NMFS expects the following species and life stages to be present during the pile driving portion of the construction in-water work window from July 15 through November 30 for 2023 and 2024 season:

- adult CCV steelhead
- adult and juvenile sDPS green sturgeon

Quantification of the number of fish exposed to the pile driving associated noise and turbidity is not currently possible with readily available technology. All fish passing through or otherwise present during construction activities will be exposed to noise from pile driving. Only the level of acoustic noise generated during the construction phases can be accurately and consistently measured and provide a quantifiable metric for determining incidental take of listed fish. The measurement of acoustic noise generated during the construction phase, and in particular the vibratory and impact pile driving described in the proposed project, will serve as physically measurable surrogates for the incidental take of listed fish species.

The most appropriate threshold for incidental take in the form of harm (resulting in fish displacement, behavior modification), injury, and death associated with elevated underwater noise is an ecological surrogate of the amount of habitat affected by elevated underwater noise and vibration within a certain distance from the construction site. Elevated noise disturbance is also expected to elevate fish stress levels even when no observable behavior changes are made, and are expected to decrease individual's overall fitness and survival through compounding sub-lethal effects.

As described and analyzed in the effects section, vibratory pile driving is expected to produce underwater pressure levels over 150 dB RMS out to 2,154 meters from the location of the pile driving sites. Beyond 2,154 meters, underwater sound is expected to attenuate down to effective quiet, or 150 dB RMS or less. Therefore 2,154 meters from the pile being driven is considered the limit of this ecological surrogate. The behavioral surrogate will be limited in general to 2,154 meters from the boundary of the construction footprint and cofferdam placement, and exceeding 150 dB RMS beyond 2,154 meters from the construction site boundary will be considered exceeding expected incidental take levels for this surrogate.

As described and analyzed in the effects section, impact pile driving is also expected to produce underwater pressure waves that are expected to injure or kill CCV steelhead and sDPS green sturgeon within 18 meters of the pile being driven. The lethal distance surrogate will be limited to an 18-meter radius from each pile driven with an impact hammer. The injurious distance surrogate will be limited 1,597 meters from the construction site boundary, and exceeding 206 dB peak or 187 dB cumulative SEL, respectively, beyond these distances will be considered exceeding expected incidental take levels for these surrogates.

2.9.1.3. Incidental take associated with barge and boat traffic noise

- ***Barge and boat traffic noise*** – The ecological surrogate for underwater noise from barge and boat traffic is observation of erratically behaving fish within 500 feet of construction activity in adjacent waterways during any 24-hour period.

During construction of the tidal gate, barges and boats (including tug boats) would be needed to transport materials and machinery. NMFS expects the following species and life stages to be present during the year-round barge and boat traffic:

- adult and juvenile CCV steelhead
- adult and juvenile CV spring-run Chinook salmon
- adult and juvenile sDPS green sturgeon

Quantification of the number of fish exposed to the underwater noise from barge and boat traffic is not currently possible with readily available technology. All fish passing through or otherwise present during construction activities will be exposed to construction noise. Based on the project description and effects analysis, elevated noise disturbance is expected to elevate fish stress levels even when no observable behavior changes are made, and are expected to decrease individual's overall fitness and survival through compounding sub-lethal effects.

The most appropriate threshold for incidental take in the form of harm, resulting in fish displacement, behavior modification, due to elevated underwater noise is an ecological surrogate of the amount of habitat affected by elevated underwater noise within 500 feet distance from the construction site. This would result in reduced survival and fitness to ESA-listed fish. Any observations of erratically behaving fish within 500 feet of construction activity in adjacent waterways during any 24hour period will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation on the Project.

2.9.1.4. Incidental take associated with operations and maintenance of the flood gate

- ***Operations and Maintenance of the flood gate*** – The ecological surrogate for fish exposure to entrapment behind the flood gates is operation of the gates at water elevations greater than +8 feet NAVD88 only occurring during the period from November 1 through April 30.

NMFS expects that during the operations of the flood gate structures, closures for water elevations greater than +8.0 feet NAVD88 will occur only during the period from November 1 through April 30. NMFS expects the following species and life stages to be present during this portion of the proposed project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

All listed species identified above would be exposed to the operations of the Smith Canal flood control structure. NMFS expects that incidental take would occur in the form of mortality or morbidity resulting from entrapment of listed fish behind the closed gate. Trapped fish would have an elevated vulnerability to predation and exposure to degraded water quality in the waterbodies upstream of the closed gate structures. Gate closures would occur during high tides or water elevations exceeding +8.0 feet NAVD88 or when in operation for maintenance purposes. Therefore, the frequency of gate operations is defined by the water elevation and is used as the ecological surrogate for the exposure of fish to entrapment behind the gates. Operations of the gates at water elevations below +8 feet NAVD would result in more frequent operations of the flood gate structure which would result in more occurrences of entrapped fish. These conditions would indicate incidental take has been exceeded, triggering the need to reinitiate consultation on the proposed project.

The level of incidental take is associated with the creation of a high velocity flow through the narrow gate opening, designed to be approximately 50 feet wide. The width of the gate is an integral factor in determining the velocity of the water flowing through the open gate, as well as the water elevation differential between the two sides of the flood structure. If the gate opening is made narrower, the velocity increases, thereby creating more adverse conditions for listed fish passing through it. Higher velocities create more turbulence, eddies, and disorientation to the fish caught in the high velocity jet, allowing them to become easier targets for predators. A wider gate opening would have the opposite effect, reducing the velocity of the flow. NMFS considers any changes to the gate opening that would make it narrower and thus increases the velocity of water moving through the open gate as exceeding anticipated incidental take as analyzed in this biological opinion. The level of take associated with placing a vertical structure in the channel (*i.e.*, the sheet pile wall) is related to the linear length of the wall, and the holding and hiding habitat that it can provide to predators residing in the area. Increasing the length of the wall would increase the potential predator holding habitat. Conversely, shortening the length of the wall would reduce the predator holding habitat. NMFS considers any changes to the length of the wall that demonstrably increases its linear length (currently designed to be approximately 800 feet for Smith Canal) would exceed the anticipated incidental take of listed fish as assessed in this biological opinion.

2.9.1.5 Incidental Take Associated with the Permanent Loss of Habitat

- ***Square footage of area impact for permanent structure and riprap placement*** - The proposed project would result in permanent impacts to approximately 0.820 acres of tidal perennial drainage and 0.83 acres of riparian habitat. In addition, 0.386-acre of 18-inch RSP will be placed around the gate structure. This square footage will serve as the ecological surrogate.

NMFS expects that there will be permanent loss of habitat associated with the placement of the tidal gate structure and RSP. NMFS expects the following species and life stages to be present during this portion of the proposed project operations:

- adult and juvenile CCV steelhead
- adult and juvenile sDPS green sturgeon
- adult and juvenile CV spring-run Chinook salmon

The finalization of the flood control project will result in a tidal gate and floodwall that will extend 800 linear feet from the tip of Dad's Point levee to the right bank of the San Joaquin River. In addition, 200 linear feet of riprap will be placed on the banks of Stockton Golf and Country Club and 0.386-acre of RSP material around the gate foundation. Therefore, the project would result in permanent impacts to approximately 1.206 acres of tidal perennial drainage and 0.83 acres of riparian habitat.

The placement of the tidal gate and riprap is expected to harm juvenile and adult ESA-listed fish. It will reduce the amount of feeding and sheltering/escapement areas locally for juveniles. A reduction in the amount of feeding and resting areas is expected to reduce the fitness of fishes that would have otherwise used this area, in perpetuity. The occupation of the permanent structure and rip rap will reduce the amount of feeding and resting areas locally, and create ambush habitat for predators of juvenile steelhead, in perpetuity. In addition, the permanent structure could change migration behavior for adult and juveniles due to the operations (changes in flow) and permanent placement of structure in the migratory corridor. NMFS considers any changes to the length of the wall that demonstrably increases its linear length (currently designed to be approximately 800 feet for Smith Canal) or increased rip rap placement would exceed the anticipated incidental take of listed fish as assessed in this biological opinion.

2.9.2. Effect of the Take

In the biological opinion, NMFS determined that the amount or extent of anticipated take, coupled with other effects of the proposed action, is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

"Reasonable and prudent measures" are measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

1) Measures shall be taken by the Corps, or its applicant, to minimize sediment events and turbidity plumes in the action area and related effects, as discussed in this biological opinion.

2) Measures shall be taken by the Corps, or its applicant, to reduce underwater sound impacts and other disturbances related to pile driving and barge and boat traffic, as discussed in this biological opinion.

3) Measures shall be taken by the Corps, or its applicant, to reduce the extent of degradation and alteration to the habitats in the action area as a result of the tidal gate and riprap placement, related to effects of this project, as discussed in this biological opinion.

4) Measures shall be taken by the Corps, or its applicant, to prepare and provide NMFS with a plan and a report describing how listed species in the action area would be protected and/or monitored and to document the observed effects of the action on listed species and critical habitat. In the report, the Corps or SJAFCA shall demonstrate how the conservation measures were incorporated.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The Corps or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

a. Since in-river turbidity values change daily, the upstream comparison value must therefore be taken daily, in association with the downstream readings. A qualified biologist shall use a held-hand turbidity monitor to conduct water quality monitoring during all in-water activities to ensure the turbidity control measures are functioning as intended. If an in-river turbidity plume is created and conditions within the plume exceed take limits (50 NTUs above ambient) for listed species, the Corps, or its applicant, shall coordinate with NMFS within 24 hours after an event that exceeds the given water turbidity surrogate, to discuss ways to reduce turbidity back down to acceptable levels.

b. The following BMPs shall be incorporated into the Project to reduce, minimize or avoid turbidity associated with construction activities:

   i. Implement appropriate measures, such as straw wattles and silt fencing, to prevent debris, soil, rock, or other material from entering the water from land.

   ii. Use a water truck or other appropriate measures to control dust on haul roads, construction areas, and stockpiles. Application of water would not be excessive or result in runoff into storm drains or waterways.

   iii. Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, additional erosion and sedimentation control measures would be implemented.

   iv. Maintain sediment and erosion control measures during construction. Inspect the control measures before, during, and after a rain event.

   v. Instruct construction workers in stormwater pollution prevention practices.

   vi. Revegetate disturbed areas with native seeds or plantings in a timely manner to control erosion.

   vii. If vegetation is not growing sufficiently it shall be replanted or provided with irrigation, if necessary.

   viii. Erosion control BMPs will be monitored for effectiveness during the active construction window and during periods of inactivity following the active construction window for effectiveness, particularly during the rainy season.

2. The following terms and conditions implement reasonable and prudent measure 2:

   a. During the seasonal in-water work windows, at least one day per week, the project activities shall not include pile-driving of any kind so that CCV steelhead and sDPS green sturgeon using the habitat may migrate or forage undisturbed.

   b. When local water temperatures are below 75°F, attenuation measures shall be used during impact pile driving to control and dampen underwater pressure wave propagation. Effective attenuation measures include:

i. Pile driving within a dewatered cofferdam or caisson.

ii. Use of a bubble curtain.

iii. Use of a cushion block.

c. Underwater sound monitoring shall be conducted during impact pile driving when water temperatures are below 75°F, to ensure incidental take limits are not exceeded according to the ecological surrogates designated.

i. No more than 150 dB RMS beyond 2,154 meters from the boundary of the construction footprint/cofferdam placement.

ii. No more than 187 dB SEL cumulative beyond 1,597 meters from the construction site boundary per day.

iii. No more than 206 dB peak beyond an 18-meter radius from each pile driven with an impact hammer.

3. The following terms and conditions implement reasonable and prudent measure 3:

Following the placement of riprap on the river bank and gate structure at the extent described in the project Biological Assessment, voids created by the riprap boulders would be filled by smaller diameter rocks/gravel when below the OHWM to avoid supporting piscivorous predator ambush habitat. After the first storm and snowmelt season following placement of this smaller gravel, the area shall be examined to ensure the smaller gravel was not scoured out and effectively removed. If it is found to be removed, the Corps or its applicant shall develop a plan for maintenance of this BMP over time so that this adverse effect can be reduced and controlled.

a. The Corps or applicant shall provide NMFS with a draft of the plan for review, and implement the plan after receiving NMFS' concurrence.

b. The Corps or the applicant shall minimize the removal of existing riparian vegetation and instream woody material (IWM) to the maximum extent practicable, and where appropriate, removed IWM will be anchored back into place or if not feasible, new IWM will be anchored in place.

c. The Corps shall continue to coordinate with NMFS during all phases of construction, implementation, and monitoring by hosting annual meetings and issuing annual reports throughout the construction period.

4. The following terms and conditions implement reasonable and prudent measure 4:

a. The Corps, or its applicant, shall provide a report of project activities to NMFS by December 31 of each year construction takes place. The report shall include a summary description of in-water construction activities, incidental take avoidance and minimization measures taken, and any observed incidents of take.

2.10. Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a proposed action on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

1) The Corps should continue supporting and promoting aquatic and riparian habitat restoration within the San Joaquin River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize adverse effects to listed species should be encouraged.

2) The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

3) The Corps should use all of their authorities, to the maximum extent feasible to implement high priority actions in the NMFS Central Valley Salmon and Steelhead Recovery Plan. High priority actions related to flood management include setting levees back from river banks, increasing the amount and extent of riparian vegetation along reaches of the Lower San Joaquin River Feasibility Study Project.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Smith Canal Gate Project.

As 50 CFR 402.16 states, reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion, or (4) a new species is listed or critical habitat designated that may be affected by the action.

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)]

This analysis is based, in part, on the EFH assessment provided by the Corps and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

The geographic extent of salmon freshwater EFH is described as all water bodies currently or historically occupied by PFMC managed salmon within the USGS 4th field hydrologic units identified by the fishery management plan (PFMC, 2014). This designation includes the Lower San Joaquin River (HUC 18040002) for all runs of Chinook salmon that historically and currently use these watersheds (spring-run, fall-run, and late fall-run). The Pacific Coast salmon fishery management plan also identifies Habitat Areas of Particular Concern (HAPCs): complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation, of which, the HAPC for complex channel and floodplain habitat is expected to be either directly or indirectly adversely affected by the proposed action. Because of the extensive urbanization that has occurred in the California Central Valley over the last 100 years, the San Joaquin River in the action area has been leveed and channelized and is currently degraded habitat for complex channel and floodplain HAPC.

3.2. Adverse Effects on Essential Fish Habitat

Effects to the HAPC for complex channel and floodplain habitat are discussed in the context of effects to critical habitat PBFs as designated under the ESA and described in section 2.5.2. A list of adverse effects to this EFH HAPC is included in this EFH consultation, which are expected to be similar to the impacts affecting critical habitat, including: sediment and turbidity, in-channel disturbance from pile driving, and permanent habitat loss/modification.

Sediment and turbidity

- Degraded water quality (temporary sedimentation and turbidity)

In-channel disturbance from pile driving

- Channel disturbance and noise pollution from pile driving activity and associated piles

Permanent habitat loss/modification

- Permanent habitat loss due to placement of riprap
- Reduced shelter from predators
- Reduction/change in aquatic macroinvertebrate production
- Reduced habitat complexity
- Reduced water quality (flow and contaminants) due to the operations of the tidal gate
- Permanent loss of habitat due to placement of tidal gate

3.3. Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

The following are EFH conservation recommendations for the proposed project:

To address the adverse effects of sediment and turbidity:

Implement BO Section 2.9.4 Terms and Condition 1.

To address the adverse effects of in-channel disturbance from pile driving:

Implement BO Section 2.9.4 Terms and Condition 2.

To address the adverse effects of permanent habitat loss/modification:

Implement BO Section 2.9.4 Terms and Condition 3 and 4.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, approximately 2.03 acres of designated EFH for Pacific Coast salmon.

3.4. Statutory Response Requirements

As required by section 305(b)(4)(B) of the MSA, Corps must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of the measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5. Supplemental Consultation

The Corps must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the Corps. Other interested users could include SJAFCA and the Central Valley Flood Protection Board. Individual copies of this opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2. Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3. Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. References

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APPENDIX A. CONSERVATION MEASURES AND WATER QUALITY ACTIONS FROM THE 2019 AND 2021 NMFS BIOLOGICAL OPINION THAT ARE PART OF THE ONGOING PROPOSED ACTION.

- Prior to any construction activities onsite, a review of all required permits and notifications will be performed to ensure requirements for environmental compliance are fully understood, specific limits of activities and work are defined and understood, and all environmental clearances and access, encroachment agreements, and permissions have been obtained from the appropriate agencies and parties.

- An approved biological monitor will be onsite during all construction activities that occur within the channel (i.e., cofferdam dewatering, pile driving). Biological monitors will be notified in advance of all work activities and locations, and scheduled to be onsite as required during vegetation clearing activities.

- To clearly demarcate the project boundary and protect sensitive natural communities, SJAFCA or its contractor will install temporary exclusion fencing (i.e., minimum 4-foot tall high-visibility orange construction fencing) around sensitive biological resource areas 1 week prior to the start of construction activities.

- Before any work occurs in the project site, a qualified biologist will conduct mandatory contractor/worker environmental awareness training to brief construction personnel on the need to avoid impacts on sensitive biological resources and the penalties for not complying with permit requirements.

- Prior to construction activities, environmentally sensitive areas will be flagged or fenced in order to clearly delineate the extent of the construction. All crews will also have a set of environmental drawings showing the locations of the known environmental areas. The plans will also define the fencing installation procedure. The project's special provisions package will provide clear language regarding acceptable fencing material and prohibited construction- related activities, vehicle operation, material and equipment storage, and other surface- disturbing activities within sensitive areas.

- Access routes and work areas will be limited to the minimum amount necessary to achieve the project goals. Unpaved routes and boundaries will be clearly marked prior to initiating construction.

- All equipment will be maintained such that there will be no leaks of machine fluids such as gasoline, diesel, or oils. Containment pans will be placed under stationary equipment in the event of leaks.

- Hazardous materials such as fuels and oils will be stored in sealable containers in a designated location that is at least 200 feet from any aquatic habitat.

- The number of access routes, size of staging areas, and the total area of the activity will be limited to the minimum necessary to achieve the project goal. Project limits will be established and defined with physical markers to define access routes and maintenance areas to the minimum area necessary to complete the project; this includes locating access routes and maintenance areas outside of any drainages or creeks.

- Construction access, staging, storage, and parking areas shall be located on ruderal or developed lands to the extent possible. Vehicle travel adjacent to wetlands and riparian areas shall be limited to existing roads and designated access paths. Sensitive natural communities (e.g., wetlands, water, riparian zones) shall be conspicuously marked in the field to minimize impacts on those communities, and work shall be limited to outside the marked areas.

- Only tightly woven fiber netting or similar material may be used for erosion control. No plastic monofilament matting will be used for erosion control, as this material may ensnare wildlife or disperse into the environment, increasing the amount of plastic pollution.

- SJAFCA or its contractor will inspect and clean all equipment being used for brush clearing to minimize the spread of invasive plant species into upland refugia and tidal marsh habitat.

- Upon completion of the proposed action, all temporarily disturbed natural areas, including stream banks, will be returned to original contours to the extent feasible. Affected wetlands, stream banks or stream channels will be stabilized prior to the rainy season and/or prior to reestablishing flow. Native wetland vegetation will be reestablished as appropriate.

- SJAFCA or its contractor will implement one or more of the following actions to avoid and minimize the spread or introduction of terrestrial invasive plant species. In addition, SJAFCA will coordinate with the San Joaquin County Agricultural Commissioner to ensure that the appropriate Best Management Practices (BMPs) are implemented for the duration of the construction of the proposed action.

    a. Educate construction supervisors and managers about the importance of controlling and preventing the spread of invasive plant infestations.
    b. Use eradication methods that have been approved by or developed in conjunction with the San Joaquin County Agricultural Commissioner during terrestrial invasive species removal to prevent dispersal of the species and/or destroy viable plant parts or seeds. Methods may include use of herbicides approved for use in and near waterways and seasonal removal (i.e., prior to flower and fruit production).
    c. Minimize surface disturbance to the greatest extent feasible to complete the work.
    d. Use native, noninvasive species or nonpersistent hybrids in erosion-control plantings to stabilize site conditions and prevent invasive plant species from colonizing.
    e. Use erosion-control materials that are weed-free or contain less than 1% weed seed.

- Vegetation will be cleared only where necessary and will be cut approximately 4 inches above soil level. This will allow plants to regrow after construction. All clearing and grubbing of woody vegetation will be done using hand tools, small mechanical tools, or backhoes and excavators.

- Prior to use of the proposed staging area adjacent to the San Joaquin River, or any other potential staging area that is not graded or paved, SJAFCA will retain a qualified wetland delineator to assess the staging area for the presence of any potential waters of the United States. This assessment does not need to be a complete delineation according to all USACE requirements, but will be adequate for the purposes of determining the approximate boundaries of any potential wetlands or other waters of the United States so that they can be avoided. If potential wetlands or other waters are found within the staging area, they will be shown on a map, fenced, and avoided during all construction activity, including a suitable buffer to avoid any long-term impacts.

- All slopes or unpaved upland areas temporarily disturbed by construction activities will be revegetated at least 3 days prior to a forecasted rain event with an erosion control seed mix that consists of grasses and herbaceous species that are native or naturalized to the region. The temporarily disturbed areas will be restored to pre-project topography and hydrology to the greatest extent possible.

- To prevent introduction and/or transport of aquatic invasive species into or from creeks, sloughs or other wetted channels in the Action Area, any equipment that comes into contact with the channel will be inspected and cleaned before and after contact, according to the most current Inspection Standards and Cleaning and Decontamination Procedures (DiVittorio et al. 2012).

Water Quality Measures

Subject to requirements of Section 402 of the Federal Clean Water Act, and the National Pollutant Discharge Elimination System (NPDES) permitting process, all construction projects that disturb more than one acre of land are required to prepare and implement a stormwater pollution prevention plan (SWPPP). The consulting firm selected to prepare detailed construction plans and will also be required to prepare a SWPPP for the project and include it in project plans and specifications. The construction contractor(s) will then be required to post a copy of the SWPPP at the project site, file a notice of intent to discharge stormwater with the Central Valley Regional Water Quality Control Board (Regional Water Board), and implement all measures required by the SWPPP. SJAFCA will be responsible for monitoring to ensure that the provisions of the SWPPP are effectively enforced. In the event of noncompliance, the Regional Water Board will have the authority to shut down the construction site or fine the responsible party or parties.

The SWPPP will include the following information and stipulations:

- A description of site characteristics, including runoff and drainage characteristics and soil erosion hazard.
- A description of proposed construction procedures and construction-site housekeeping practices, including prohibitions on discharging or washing potentially harmful materials into streets, shoulder areas, inlets, catch basins, gutters, or agricultural fields, associated drainage, or irrigation features.
- A description of measures that will be implemented for erosion and sediment control, including requirements for the following:

- Conduct major construction activities involving excavation and spoils haulage during the dry season, to the extent possible;
- Conduct all construction work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to storm drains and surface waters.
- Grade and stabilize spoils sites to minimize erosion and sediment input to surface waters.
- Implement erosion control measures as appropriate to prevent sediment from entering surface waters, agricultural water features, and storm drains to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets on exposed slopes.
- A Spill Prevention and Response Plan (SPRP) that identifies any hazardous materials to be used during construction; describes measures to prevent, control, and minimize the spillage of hazardous substances; describes transport, storage and disposal procedures for these substances; and outlines procedures to be followed in case of a spill of a hazardous material. The SPRP will require that hazardous and potentially hazardous substances stored onsite be kept in securely closed containers located away from drainage courses, agricultural areas, storm drains, and areas where stormwater is allowed to infiltrate. It will also stipulate procedures, such as the use of spill containment pans, to minimize hazards during onsite fueling and servicing of construction equipment. Finally, the SPRP will require that SJAFCA be notified immediately of any substantial spill or release.
- A stipulation that construction will be monitored by SJAFCA personnel to ensure that contractors are adhering to all provisions relevant to state and Federal stormwater discharge requirements, and that SJAFCA will shut down the construction site in the event of noncompliance.

Application of herbicides would be limited to the dry season to avoid potential runoff into adjacent waterways. Herbicides will not be applied during rain events or when winds exceed 10 miles per hour to prevent transport of the herbicide to off-target areas, such as surface waters. Sprayer nozzles will be calibrated to a spray density that avoids drift during application, or a surfactant will be used with the herbicide. Herbicides will be applied at a height no more than approximately four feet above plant canopy. Contractors will follow all herbicide label and requirements.

Turbidity curtains will be used around the cofferdam, and water from the dewatering process would be pumped over the top of the cofferdam and discharged in the area surrounded by the turbidity curtain to allow any silt or suspended sediments to settle back to the channel bottom.

In-Channel Work

In-channel work, including all channel and bank modifications, will be restricted to the dry season (July 15 to October 15). In-channel work will be restricted to low-flow periods between mid-July and mid-October unless otherwise approved by appropriate agencies. This window can be extended based on river conditions, if approved in writing by NMFS. Work from the banks can occur year-round. Work requiring stream dewatering, stream crossings, or work within the live stream will not begin before July 15. To the extent feasible, all in-channel work will be done by equipment operating from dry areas outside the channel.

Special Status Fish Conservation Measures

To avoid or minimize potential injury and mortality of special-status fish species, SJAFCA proposes to implement the following fish protection measures during cofferdam construction and dewatering.

- Silt fences, fiber rolls, silt curtains, and other appropriate sediment control measures will be used to minimize sediment input to the active channel, consistent with the project.
- Lighting at the gate and along the floodwalls will be directed away from the water surface as much as possible in order to decrease the attraction of juvenile salmonids and predatory fish to the area.
- SJAFCA and/or its contractor will ensure that a qualified fish biologist is on site during cofferdam construction and dewatering to supervise fish rescue activities and document any occurrences of stressed, injured, or dead fish. The biologist will be responsible for:

  (1) identifying the appropriate capture or exclusion measures;

  (2) overseeing the monitoring, handling, and release of all captured salmonids; and

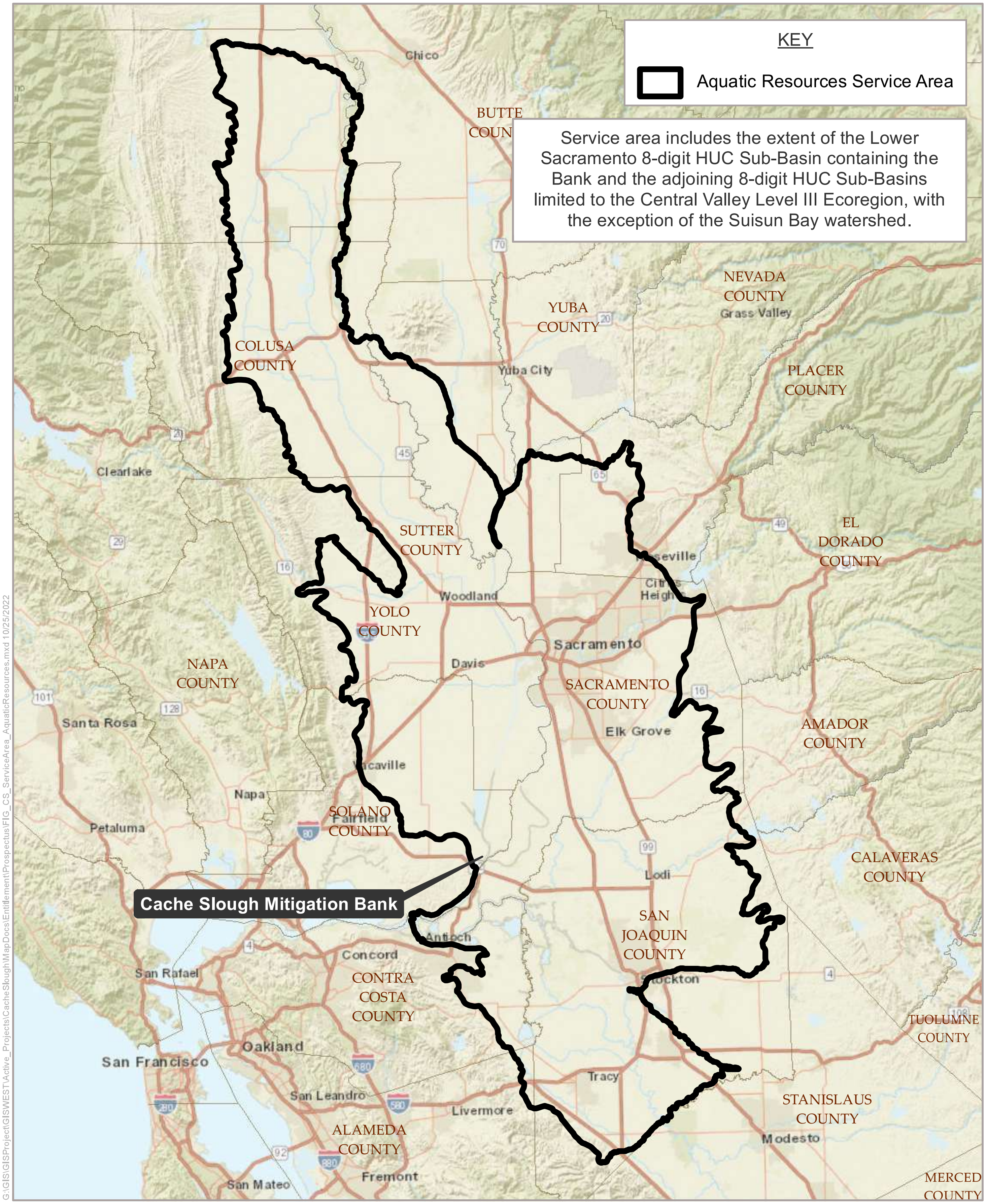
  (3) maintaining detailed records of fish rescue activities, including species, numbers, life stages, and size classes of listed species observed, collected, relocated, injured, and killed, and environmental conditions (e.g., water temperature) under which fish rescue activities are conducted.

- Potential capture methods during fish salvage will include seines, dip nets, electrofishing, or other methods that minimize the risk of injury. If electrofishing is used, all techniques will be consistent with NMFS Electrofishing Guidelines (National Marine Fisheries Service 2000).
- SJAFCA will require the contractor to implement the following measures, developed in coordination with project design engineers, to minimize the exposure of listed fish species to potentially harmful underwater sounds.
  - If feasible, the contractor will vibrate all piles to the maximum depth possible before using an impact hammer.
  - The smallest pile driver and minimum force necessary will be used to complete the work.
  - During impact driving, SJAFCA will require the contractor to use a bubble ring or similar device to minimize the extent of the interim peak and cumulative SEL to below the noise thresholds (reference the Caltrans impact pile driving handbook: http://www.dot.ca.gov/hq/env/bio/files/bio_tech_guidance_hydroacoustic_effects_110215.pdf).
  - Pile driving of gate structure piles will occur inside a dewatered cofferdam.
  - No pile-driving activity will occur at night.
  - A sound attenuation device (pile cap cushion) will be used between the drive hammer strike face and the steel piling to avoid direct steel on steel impacts.

- Construction activities will avoid submerged and emergent aquatic vegetation to the greatest extent possible.
- SJAFCA and/or its contractor will develop and implement a hydroacoustic monitoring plan prior to pile driving commencement for resource agency approval. The monitoring plan will be submitted to the resource agencies (CDFW, NMFS, USFWS) for approval at least 60 days before the start of project activities. The plan will include the following requirements:
  - SJAFCA and/or its contractor will monitor underwater noise levels during all impact pile driving activities on land and in water to ensure that that peak and cumulative SELs do not exceed fish injury or mortality thresholds.
  - If the levels are exceeded, pile driving will cease and SJAFCA and/or its contractor will contact NMFS to determine whether work can resume.
  - The monitoring plan will describe the methods and equipment that will be used to document the extent of underwater sounds produced by pile driving, including the number, location, distances, and depths of the hydrophones and associated monitoring equipment.
  - A reporting schedule that includes provision of daily summaries of the hydroacoustic monitoring results to the resource agencies and more comprehensive reports on a monthly basis during the pile driving season.
  - The final report will include the number of piles installed per day, the number of strikes per pile, the interval between strikes, the peak sound pressure level (Peak), SEL, RMS per strike, accumulated SEL per day at each monitoring station, and when these levels are exceeded, if ever.

- A fisheries biologist will be on-site during all barge movements to monitor for erratically behaving fish within 500 feet of the tugboat; if any erratically behaving fish are observed, the biologist will temporarily halt the barge movement and contact NMFS to identify the appropriate corrective actions (e.g., reduce the tugboat motor RPMs, monitor underwater noise levels to ensure RMS values do not exceed 150 dB RMS beyond 100 m of the tugboat).
- All Project boats will obey the posted speed limit of 5 mph (4.3 knots) within Smith Canal;
- All Project boats will avoid rapid acceleration within the action area;
- All Project boat motors will be turned off when not in use; and
- Movement of the barge and use of the tugboat will be restricted to the minimum amount necessary to complete the intended work.

Appendix D
Mitigation Bank Service Areas

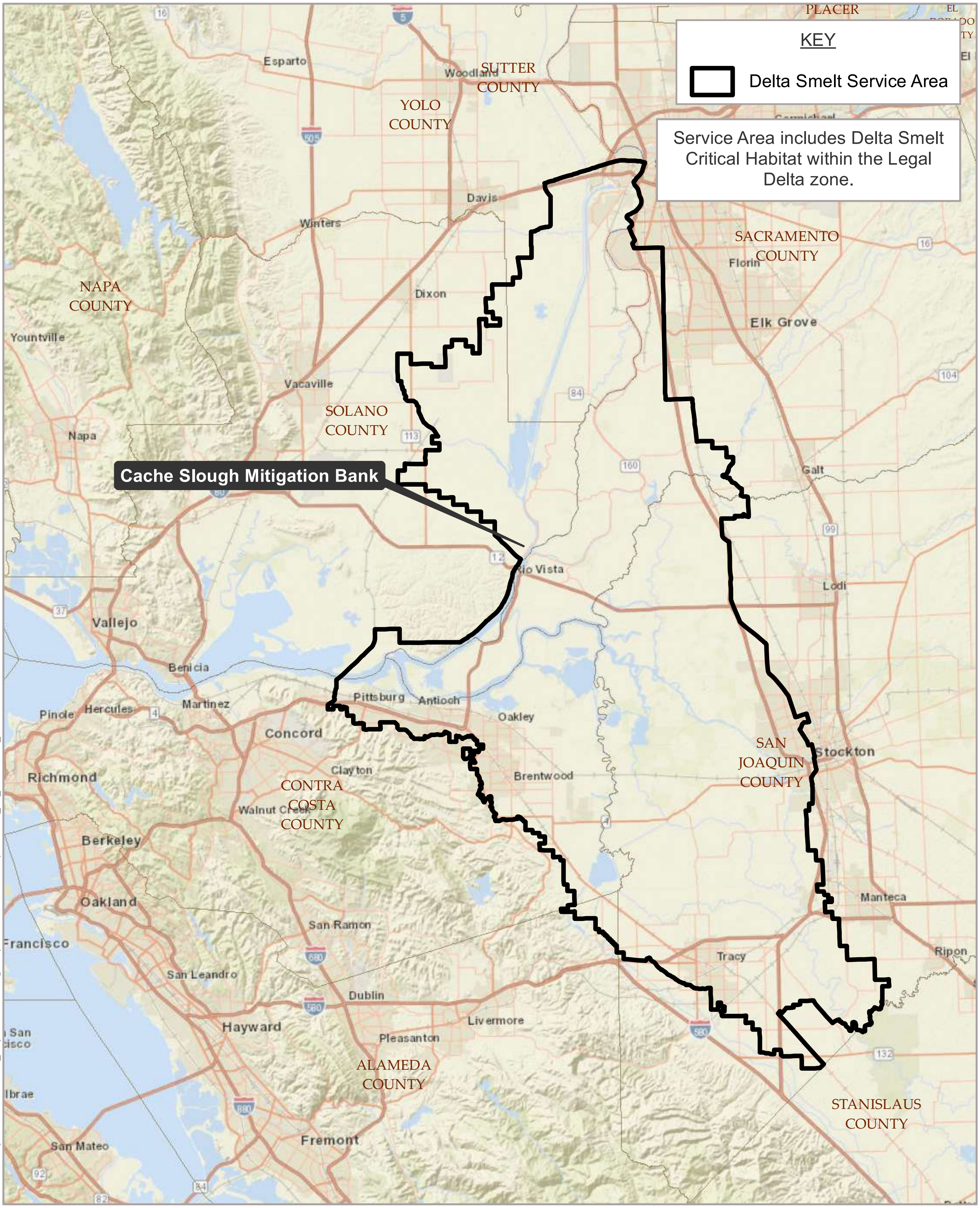


Westervelt ECOLOGICAL SERVICES

Figure 28

Aquatic Resources Service Area

Cache Slough Mitigation Bank Prospectus



Westervelt ECOLOGICAL SERVICES

0 5 10
Miles

Figure 29

Delta Smelt Service Area

Cache Slough Mitigation Bank Prospectus

Westervelt ECOLOGICAL SERVICES

Figure 30

Green Sturgeon Service Area

Cache Slough Mitigation Bank Prospectus

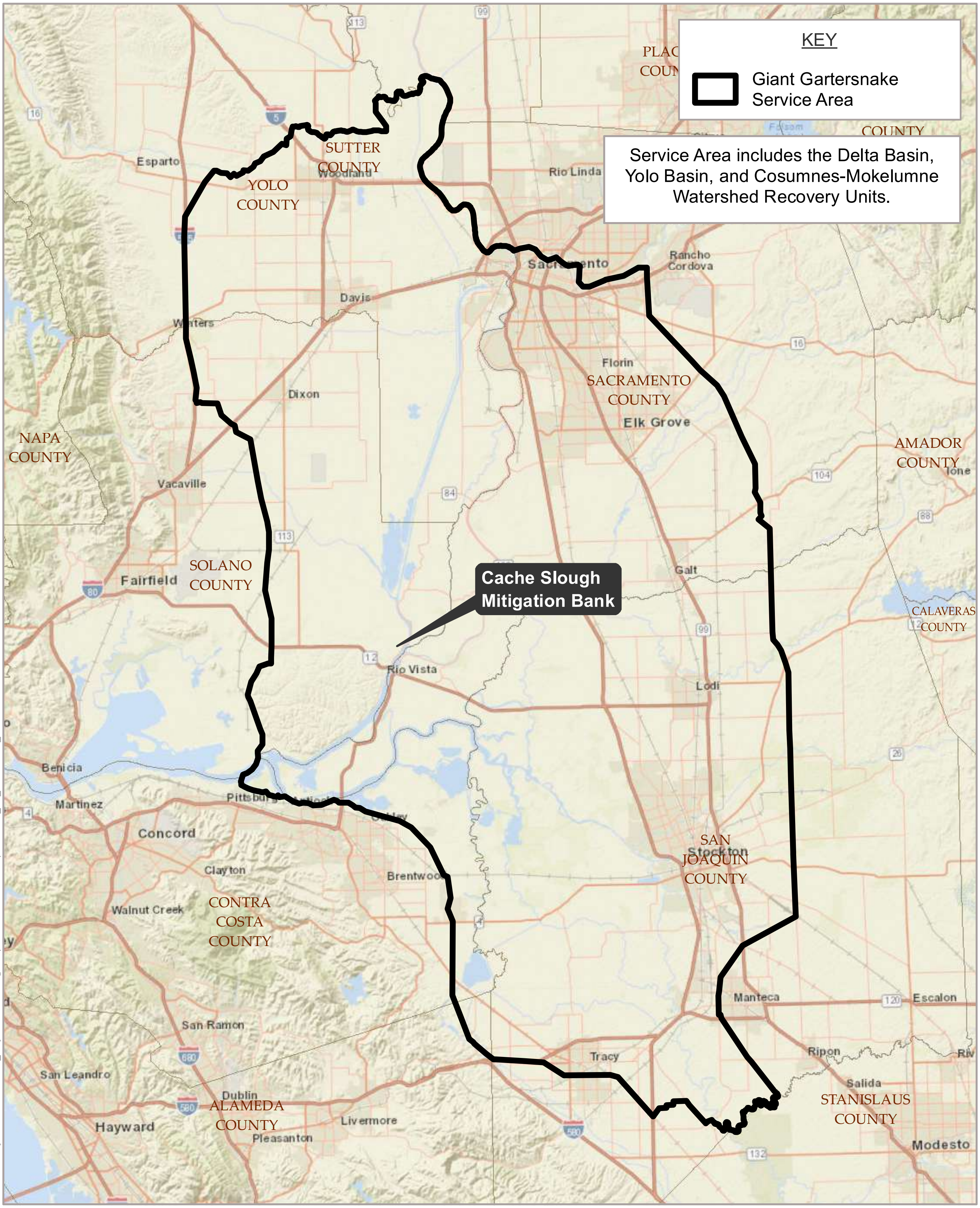
G:\GIS\GISProject\GISWEST\Active_Projects\CacheSlough\MapDocs\Entitlement\Prospectus\FIG_CS_ServiceArea_Salmonids.mxd 10/20/2022

Westervelt ECOLOGICAL SERVICES

Figure 31

Salmonids Service Area

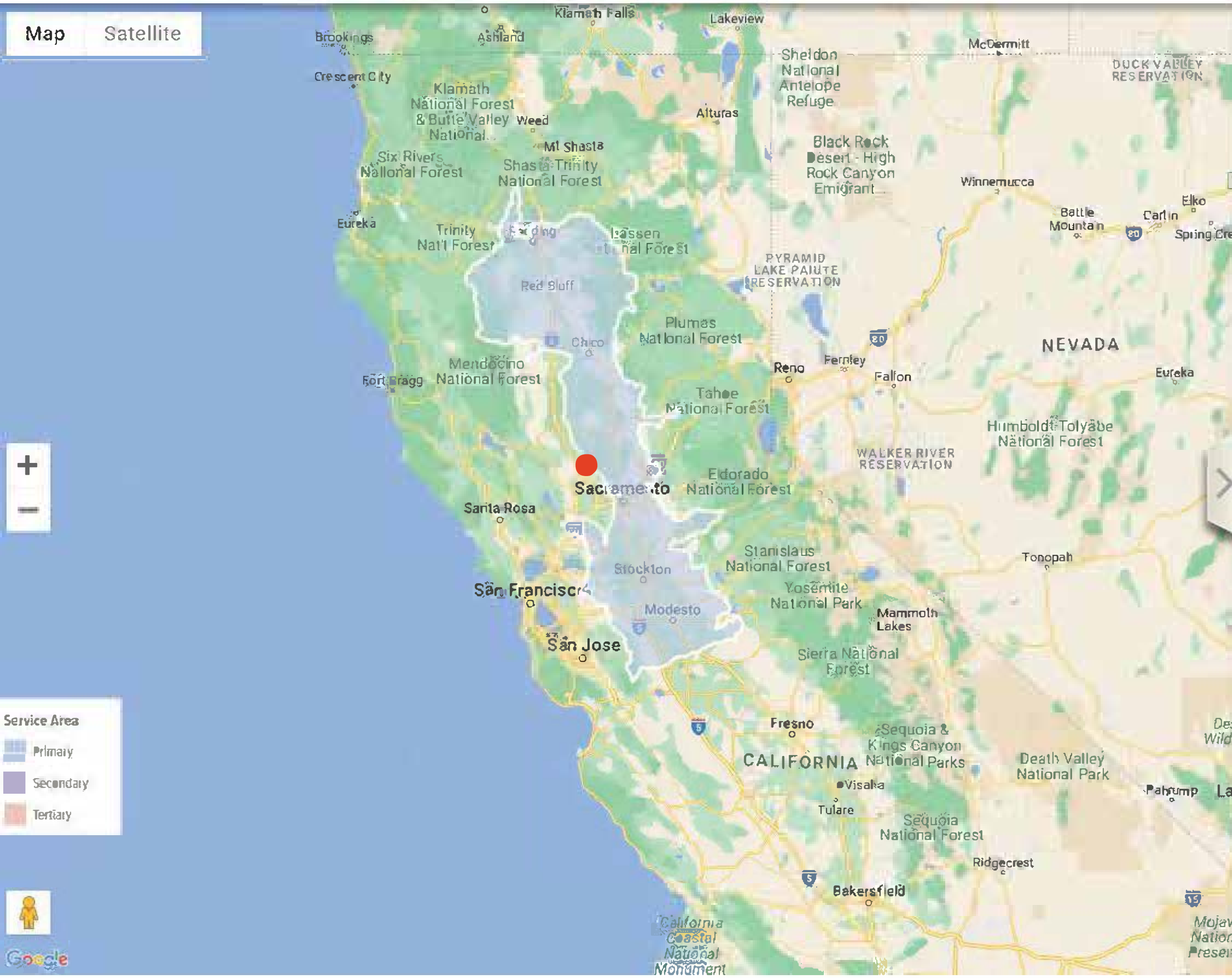
Cache Slough Mitigation Bank Prospectus



Westervelt ECOLOGICAL SERVICES

Figure 32
Giant Garter Snake Service Area
Cache Slough Mitigation Bank Prospectus

G:\GIS\GISProject\GISWEST\Active_Projects\CacheSlough\MapDocs\Entitlement\Prospectus\FIG_CS_ServiceArea_GGS.mxd 10/20/2022



BANKS AND PRESERVES

Wildlands is continuing to identify new mitigation properties. If you require a habitat type or location not identified on the map, please call us to discuss.

FREMONT LANDING CONSERVATION BANK

Salmonids	Service Area
Riparian	Service Area

Property Detail >

Blue Heron Slough Conservation Bank

Fremont Landing Conservation Bank

CBI Help

Lassen National Forest
Carson City
Nevada
Sacramento
San Francisco
Inyo National Forest
Fresno
California
Death Valley National Park
Los Angeles

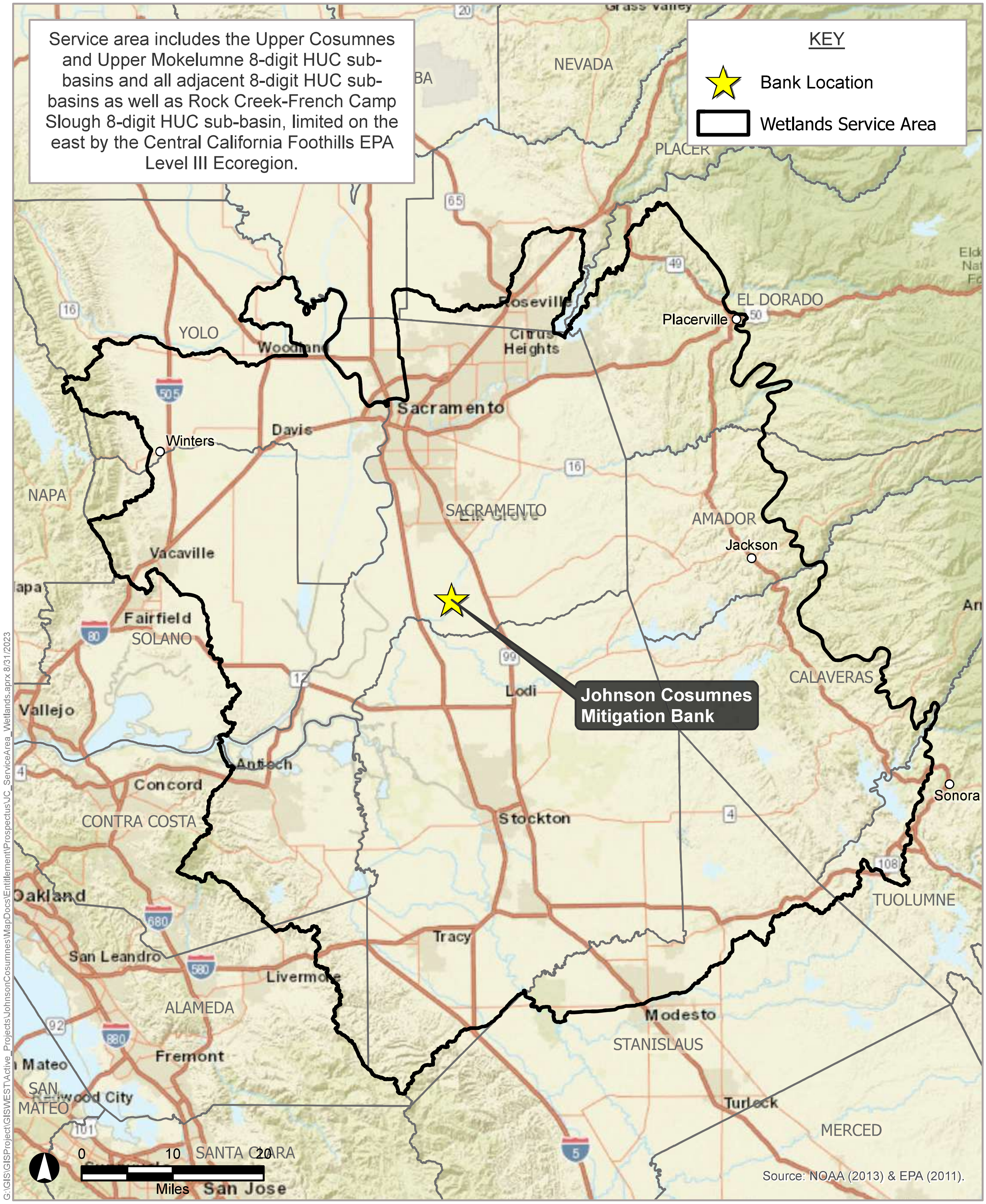
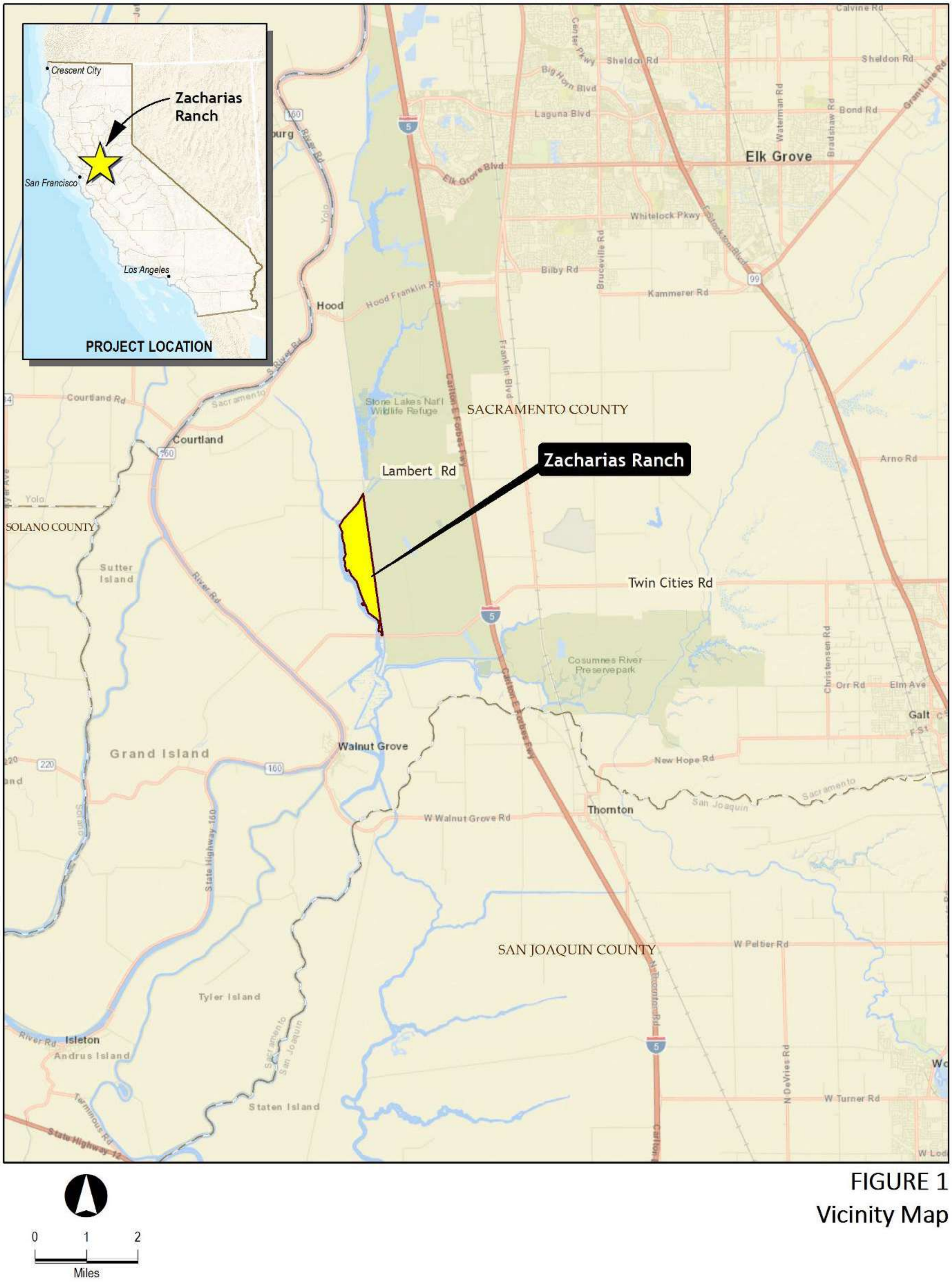


Figure 24

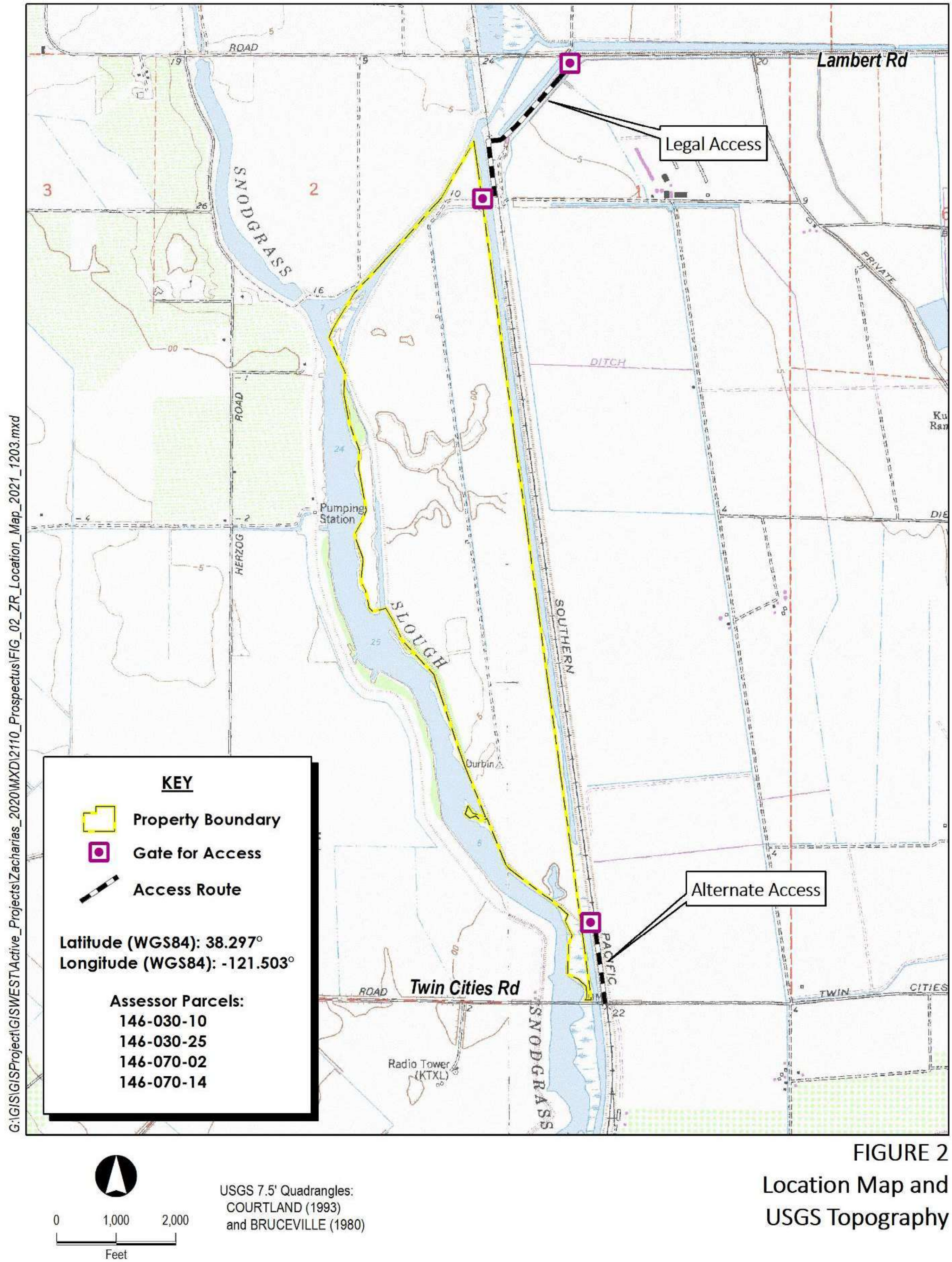
Floodplain Mosaic Wetland and Floodplain Riparian Service Area

Johnson Cosumnes Mitigation Bank



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_01_ZR_Vicinity_Map_2021_1203.mxd

FIGURE 1
Vicinity Map



USGS 7.5' Quadrangles:
COURTLAND (1993)
and BRUCEVILLE (1980)

FIGURE 2
Location Map and
USGS Topography

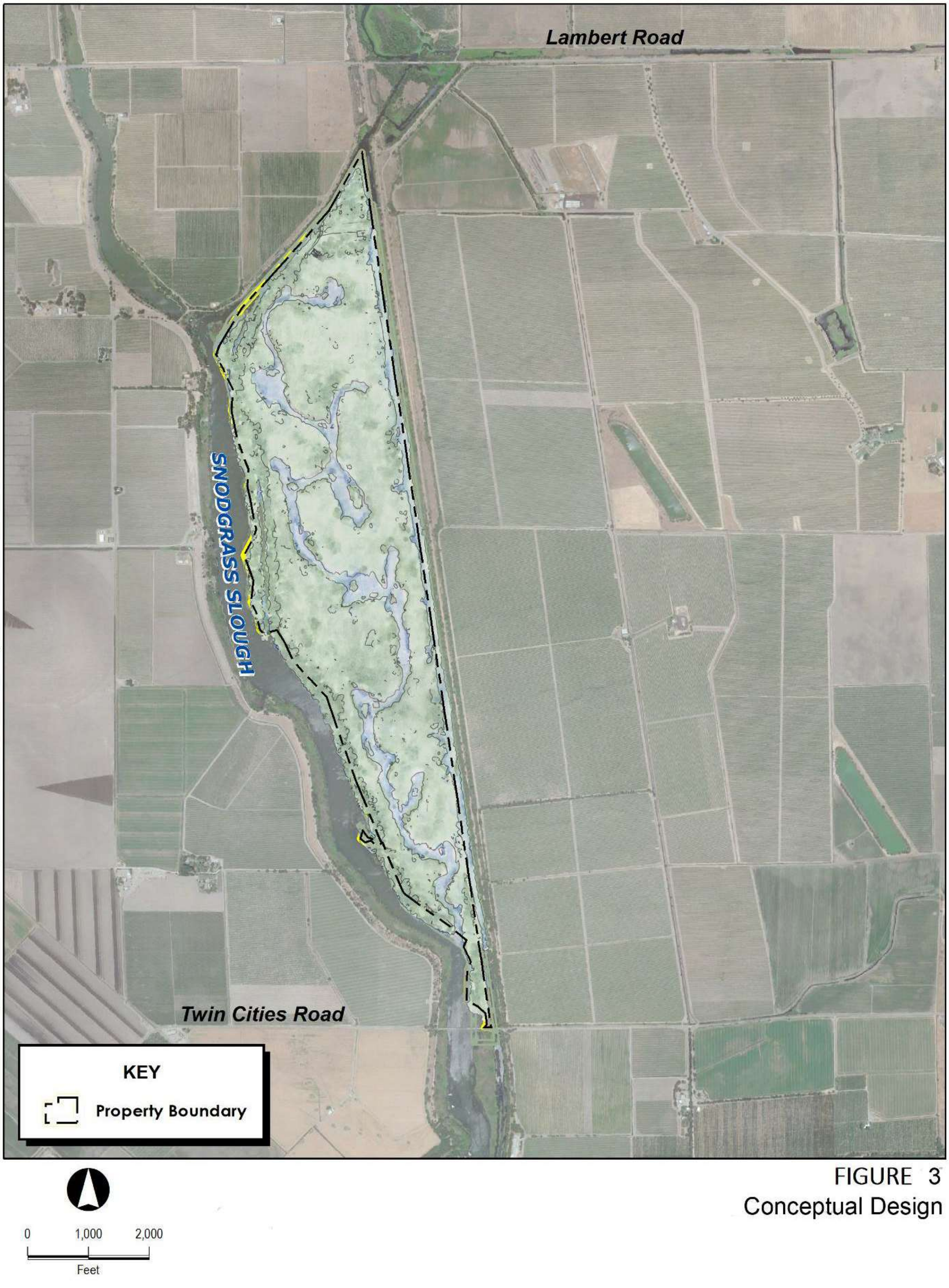
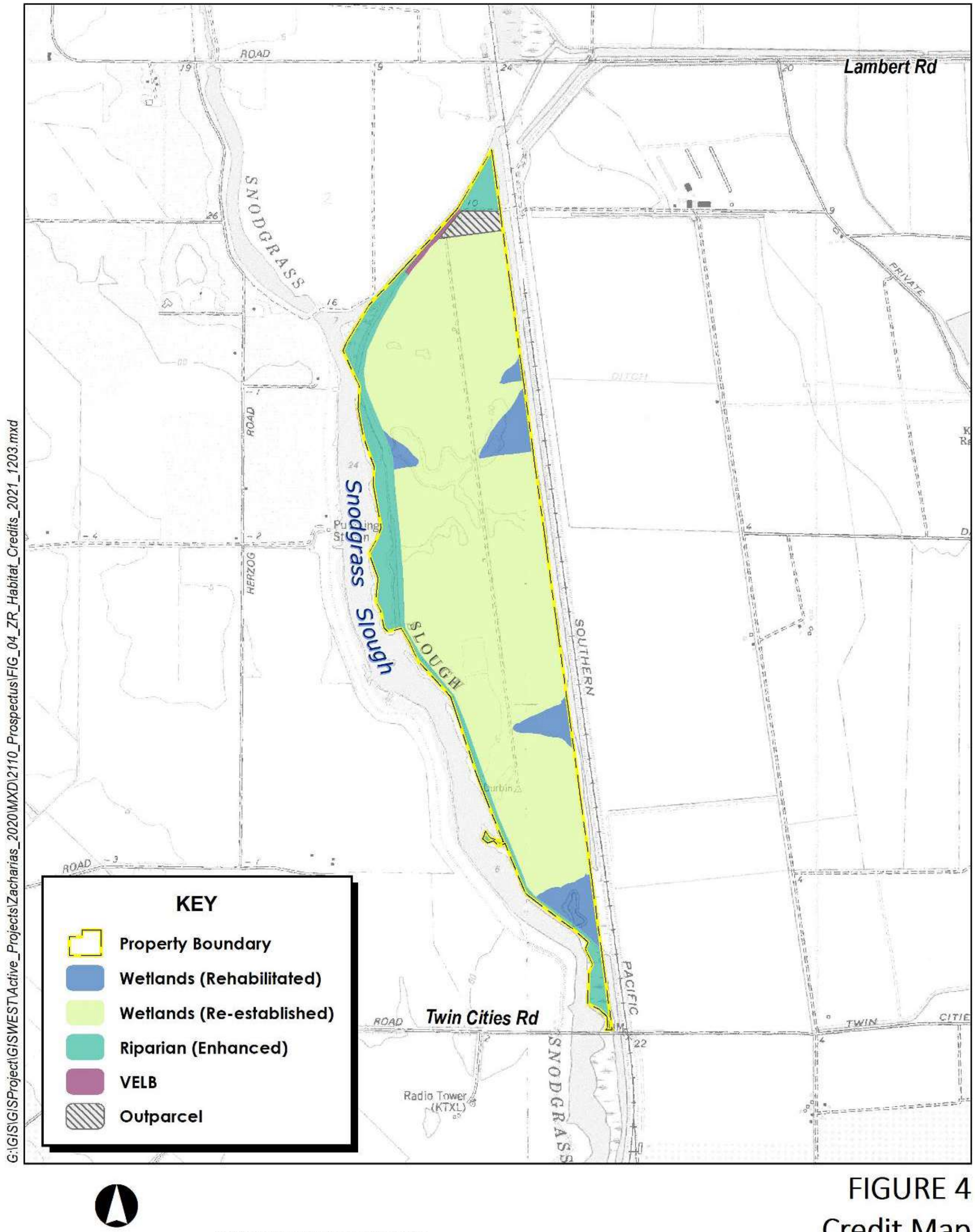


FIGURE 3
Conceptual Design

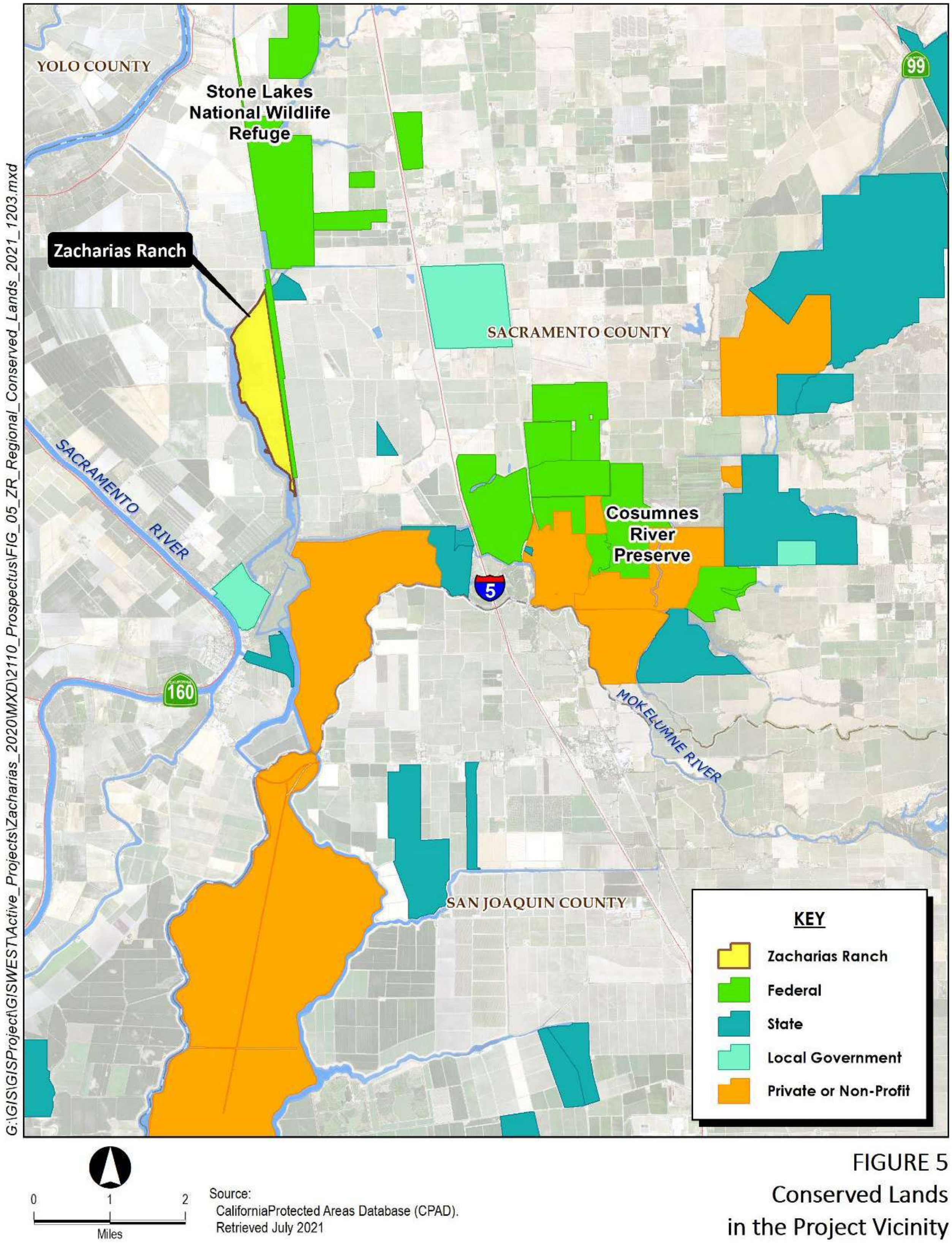


0 1,000 2,000

Feet

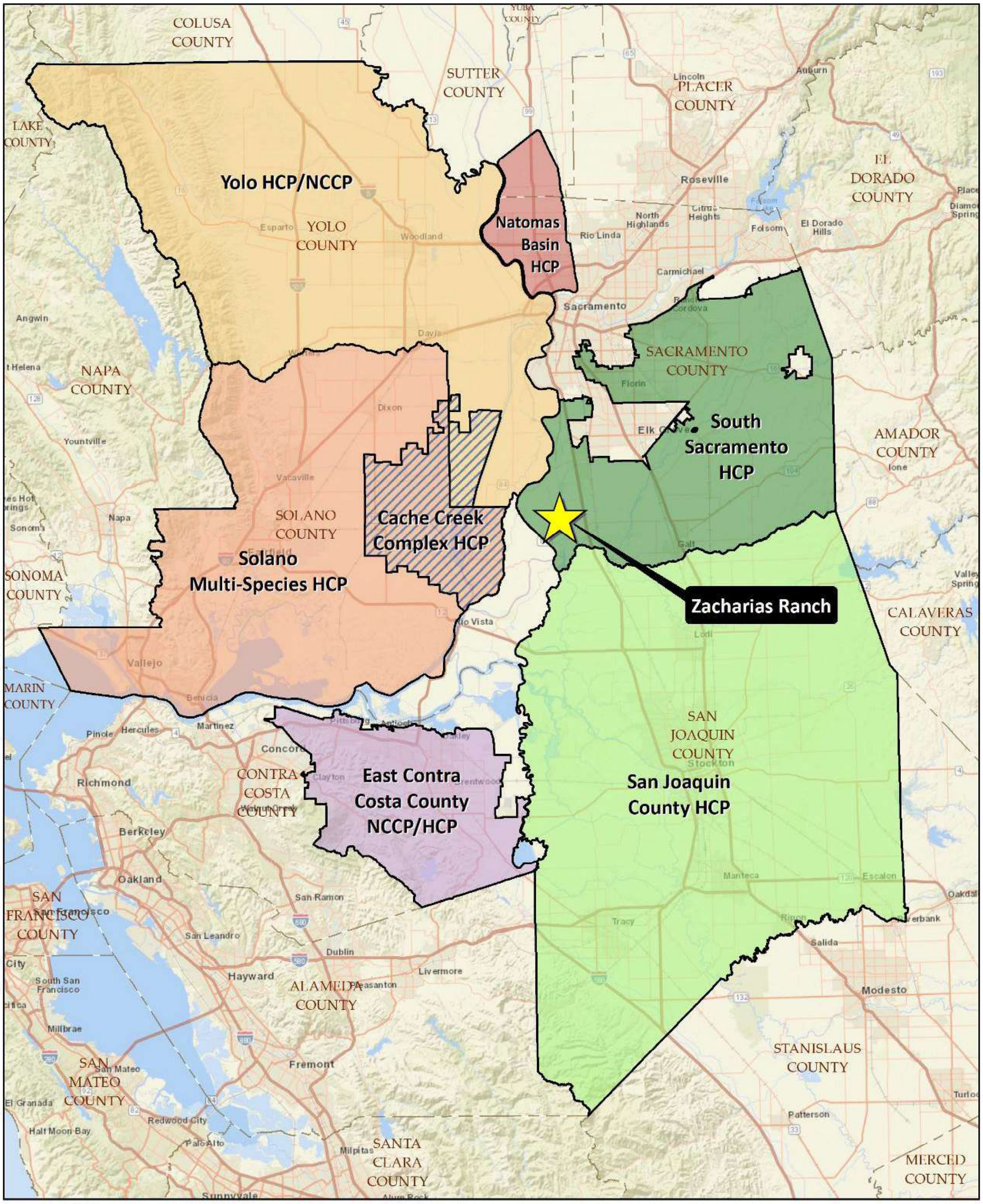
* Extents are estimates to refined with Preliminary Jurisdictional Delineation (PJD).

FIGURE 4
Credit Map



Source:
CaliforniaProtected Areas Database (CPAD).
Retrieved July 2021

FIGURE 5
Conserved Lands
in the Project Vicinity

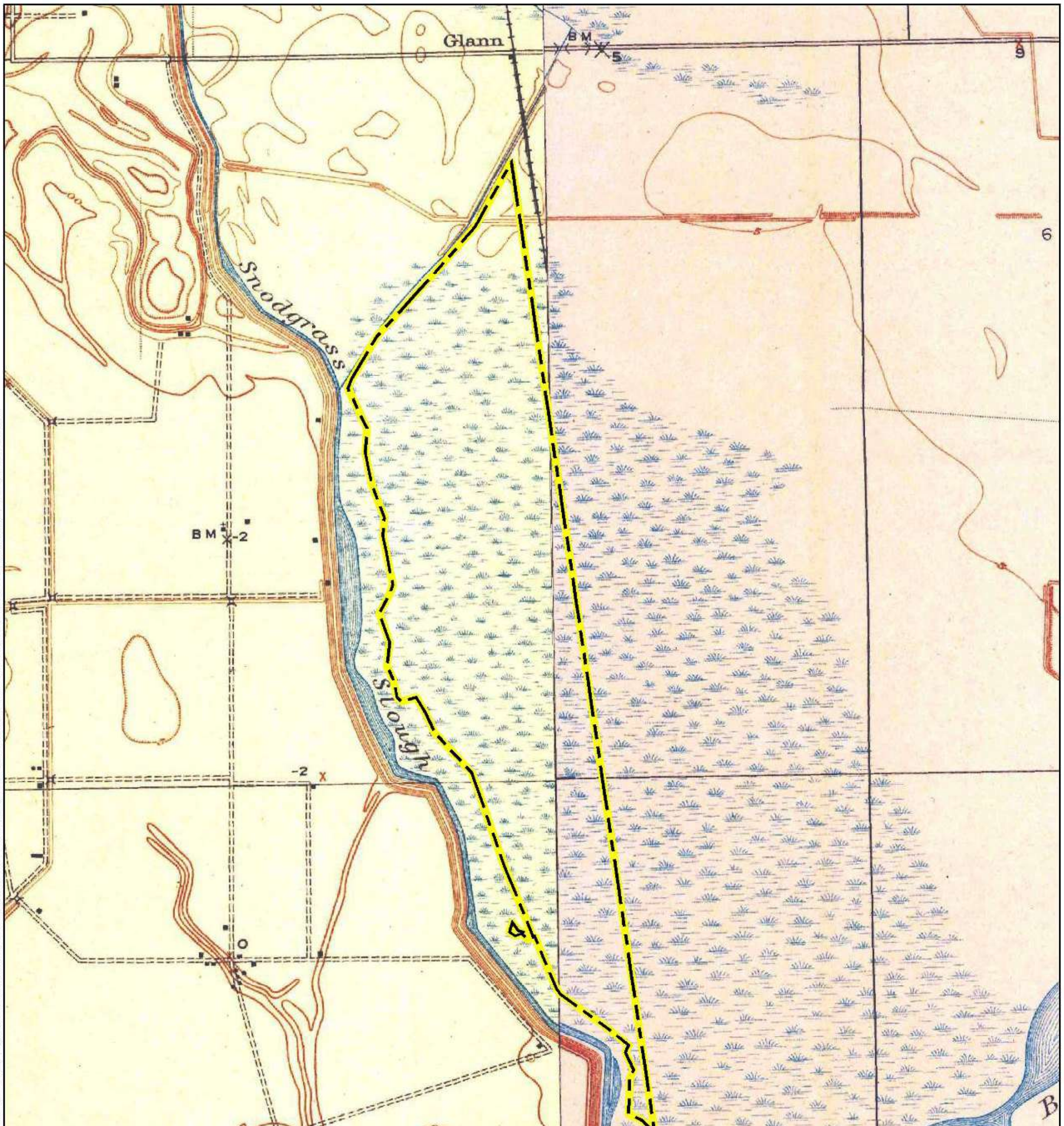


G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_06_ZR_HCPs_NCCPs_2021_1203.mxd

0 5 10
Miles

Source:
CDFW [ds760].
Retrieved November 2021.

FIGURE 6
Surrounding HCPs/NCCPs

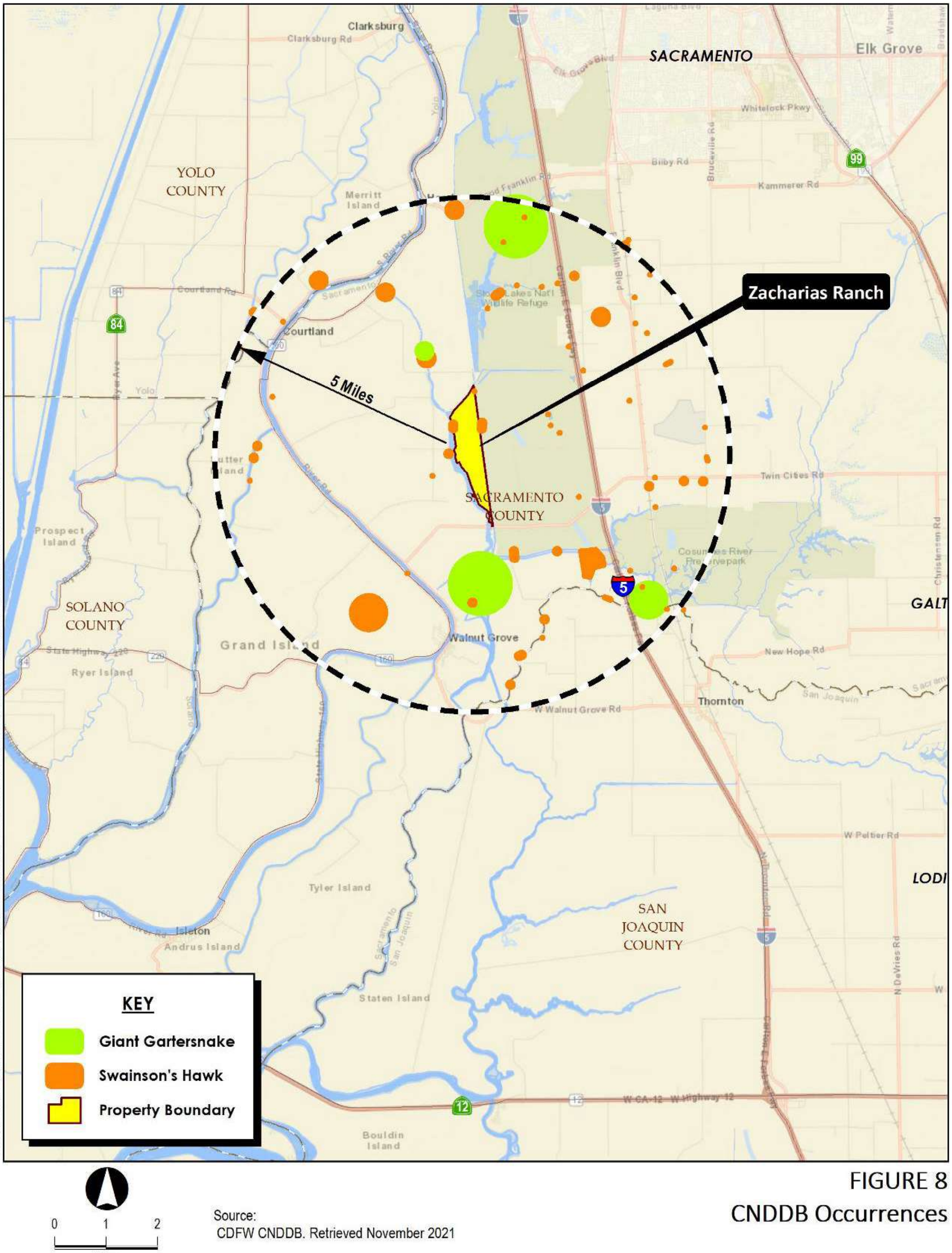


G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_07_ZR_Historical_USGS_Quads_2021_1203.mxd

0 1,000 2,000
Feet

USGS Topographic Quadrangles:
VORDEN (1916)
BRUCEVILLE (1910)

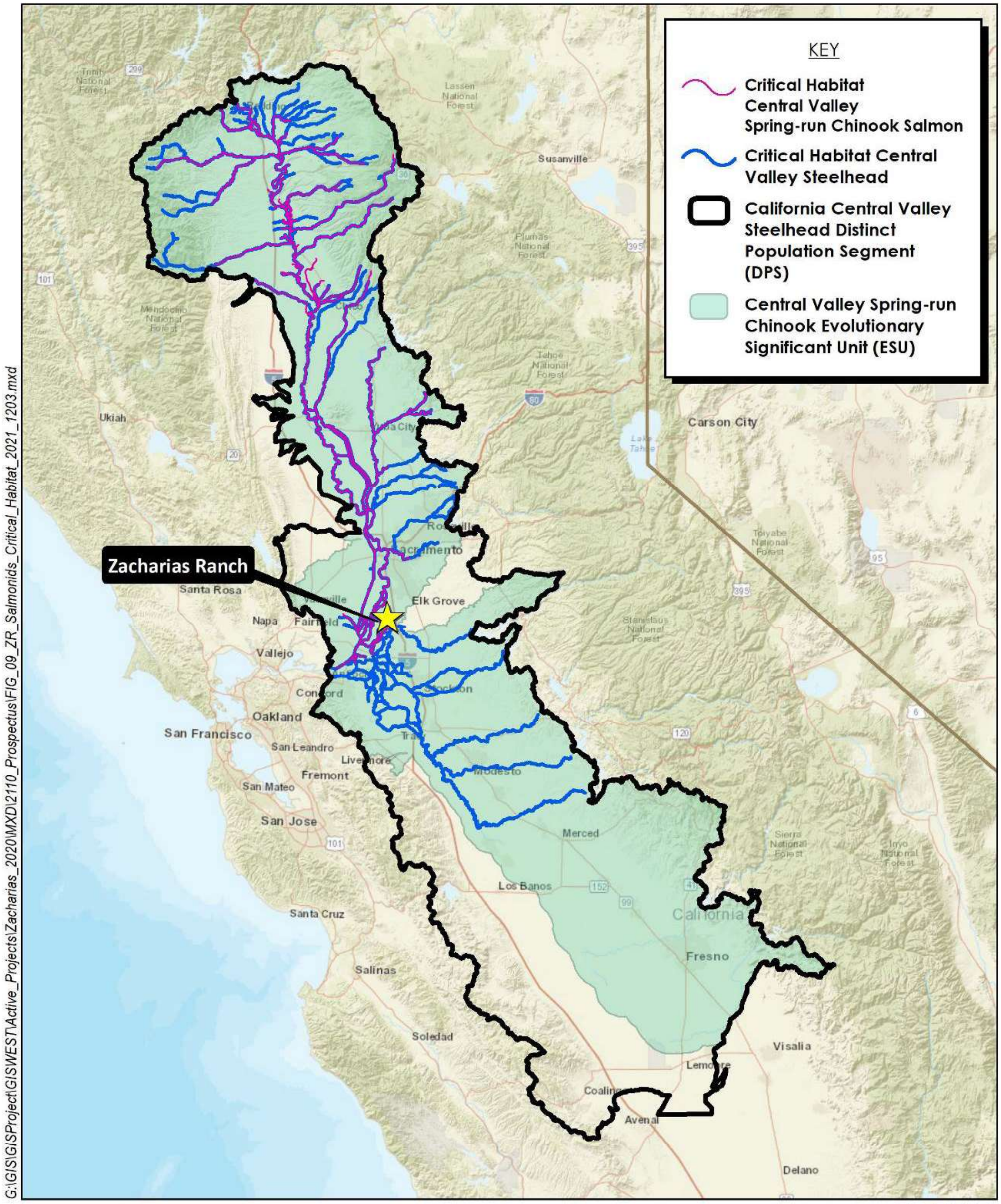
FIGURE 7
Historic USGS
Topographic Map



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_08_ZR_CNDDB_Occurrences_2021_1203.mxd

Source:
CDFW CNDDB. Retrieved November 2021

FIGURE 8
CNDDB Occurrences

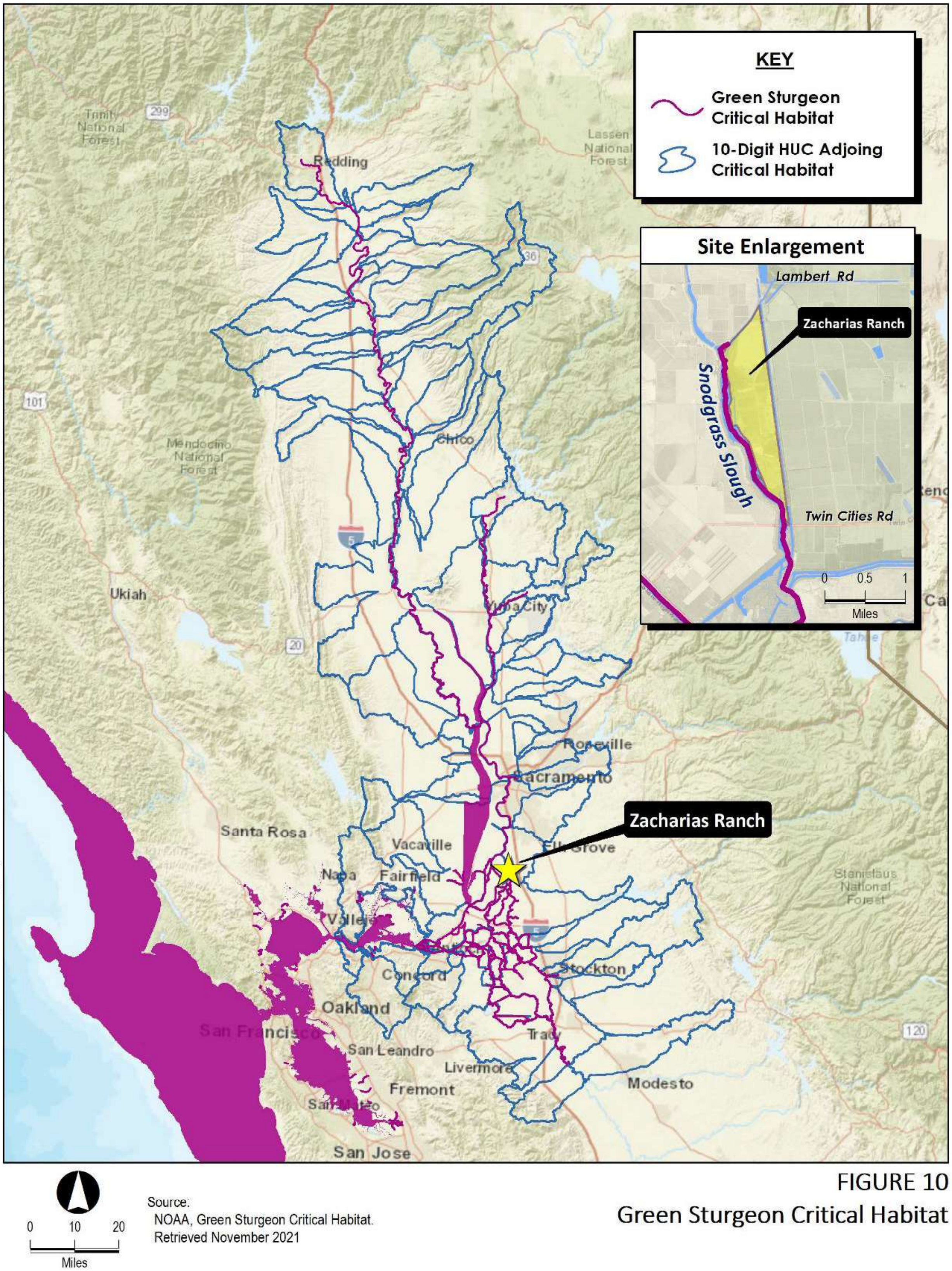


0 25 50

Miles

Source:
NOAA, Central Valley Spring-run Chinook Salmon Critical Habitat. Retrieved November 2021

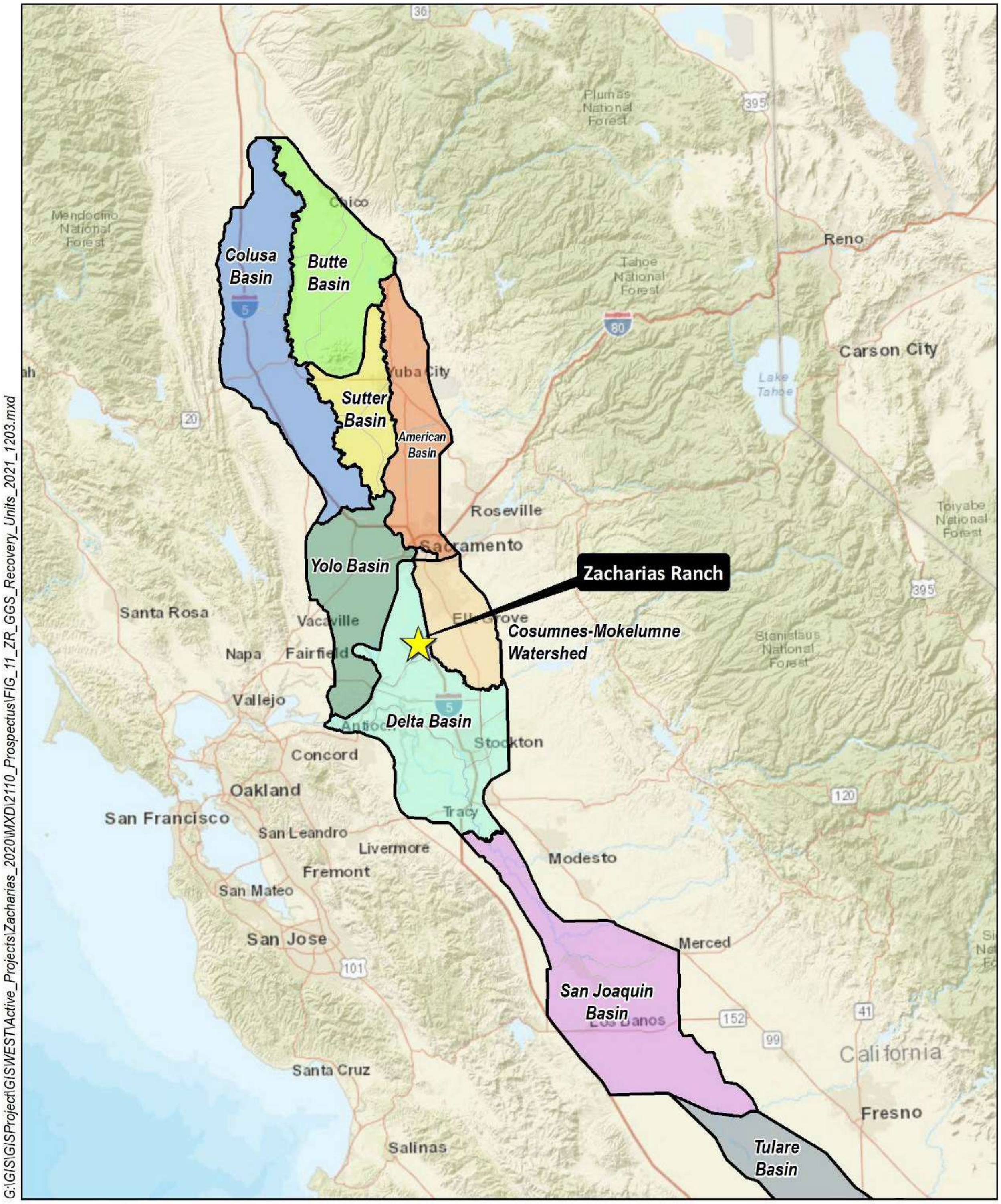
FIGURE 9
Salmonids Critical Habitat



Source:
NOAA, Green Sturgeon Critical Habitat.
Retrieved November 2021

FIGURE 10
Green Sturgeon Critical Habitat

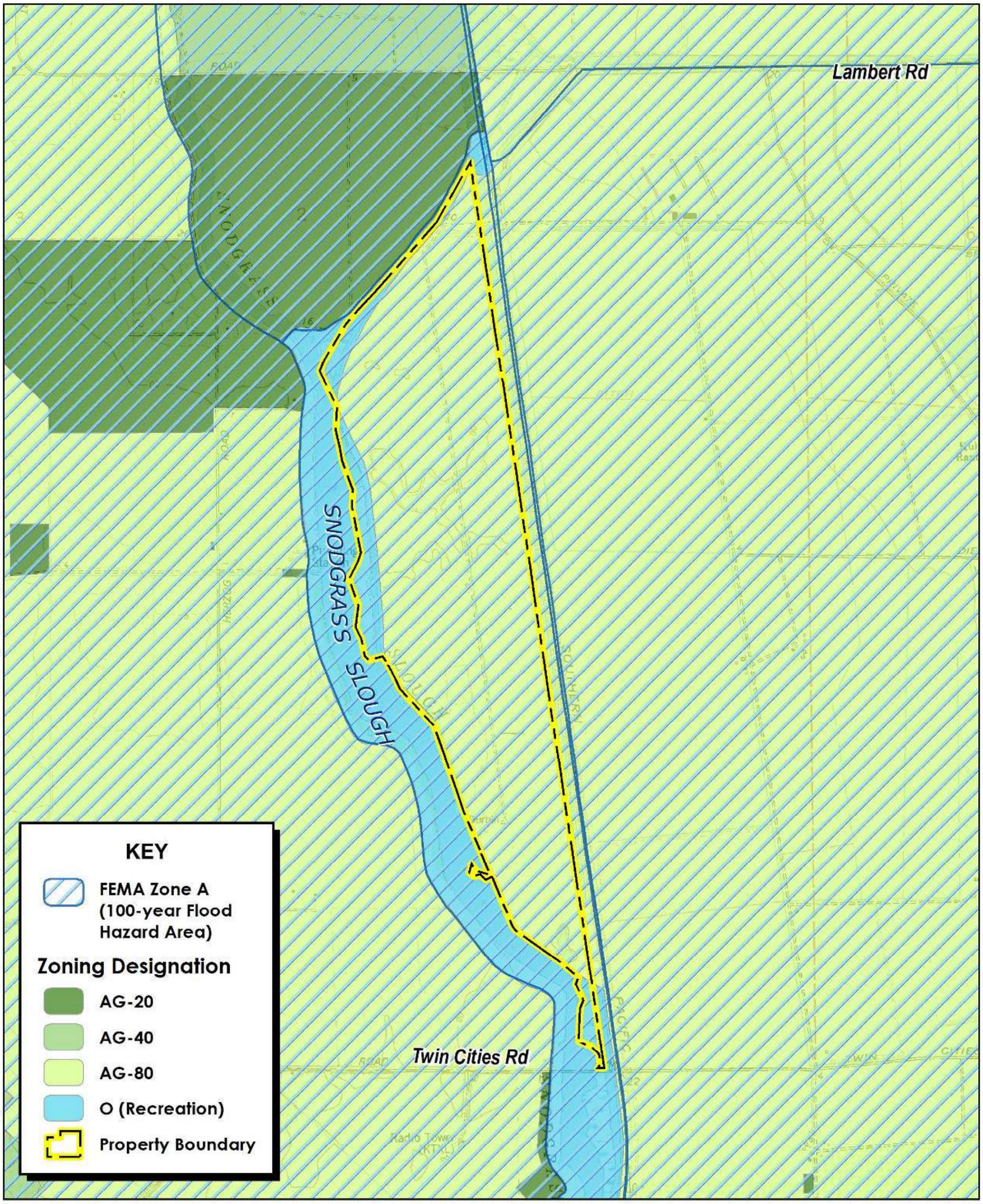
M. Lozano: G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_10_ZR_Green_Sturgeon_Critical_Habitat_2021_1203.mxd



0 10 20
Miles

Source:
USFWS, Recovery Plan for the Giant Garter Snake, 2017.
Retrieved November 2021.

FIGURE 11
Giant Garter Snake
Recovery Units



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_12_ZR_Zoning_and_Floodplain_2021_1203.mxd

0 1,000 2,000
Feet

Sources:
FEMA National Flood Hazard Layer (NFHL).
Retrieved November 2021
County of Sacramento, Planning Dept
Retrieved November 2021

FIGURE 12
Zoning and FEMA

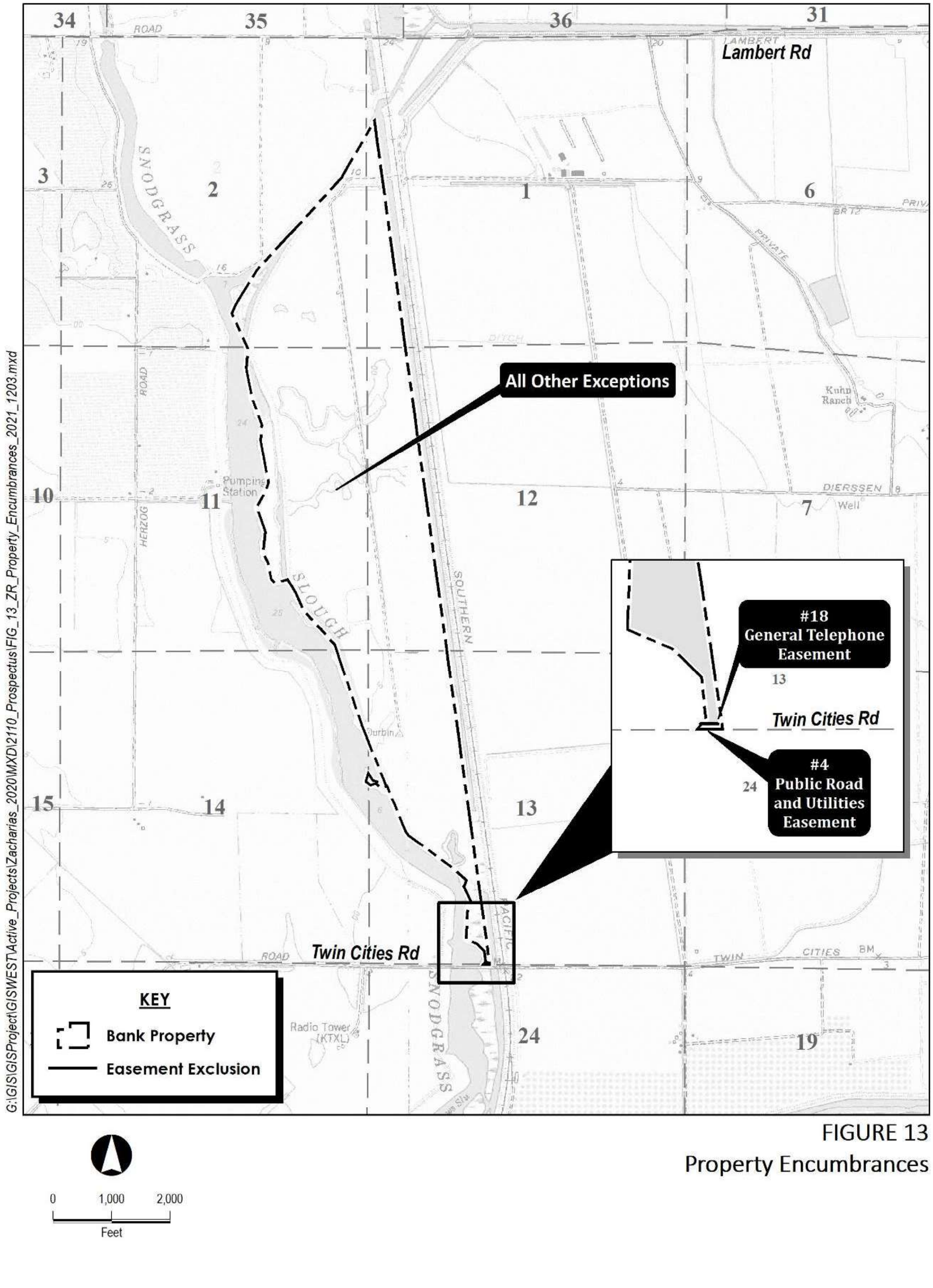
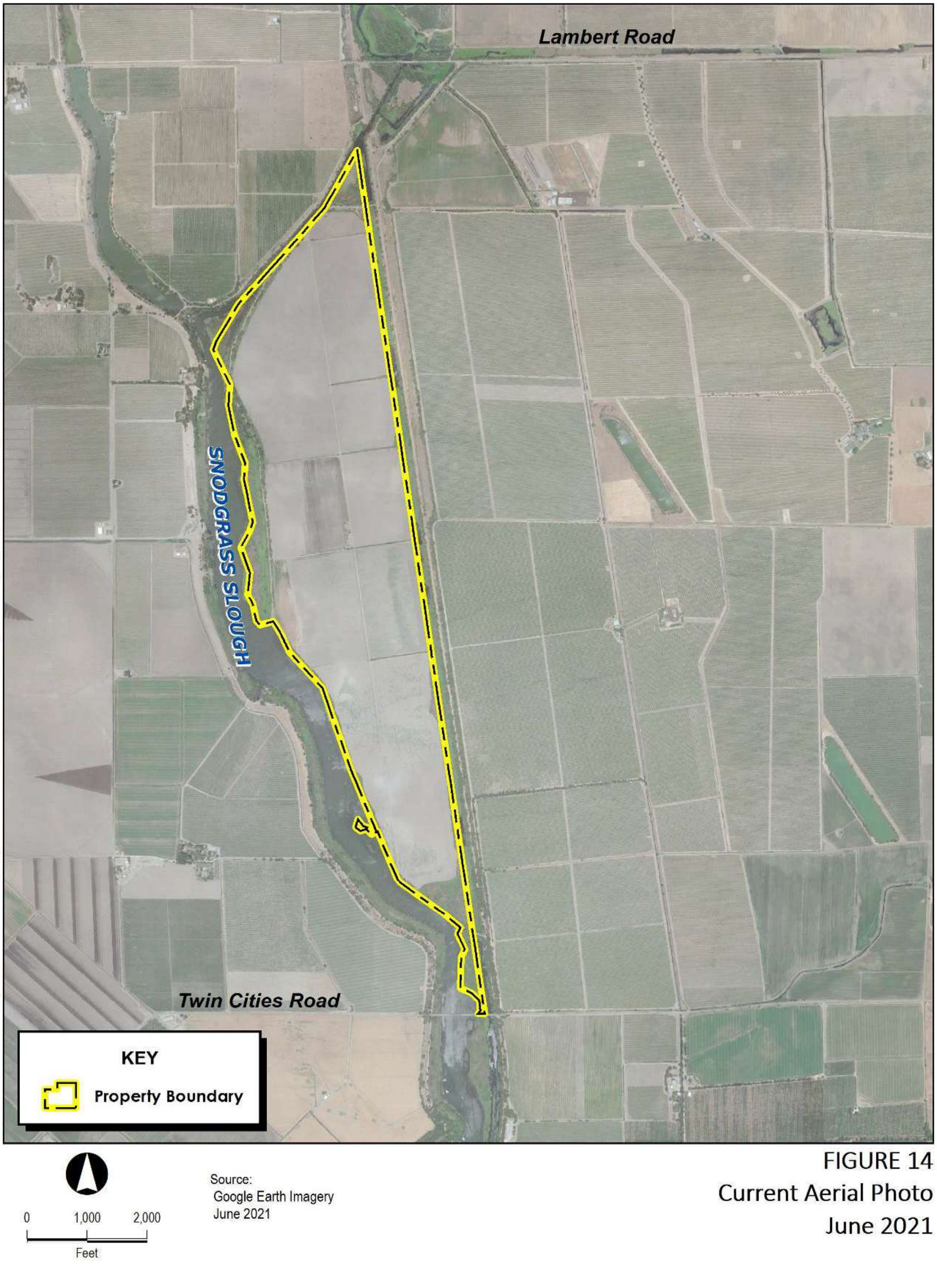


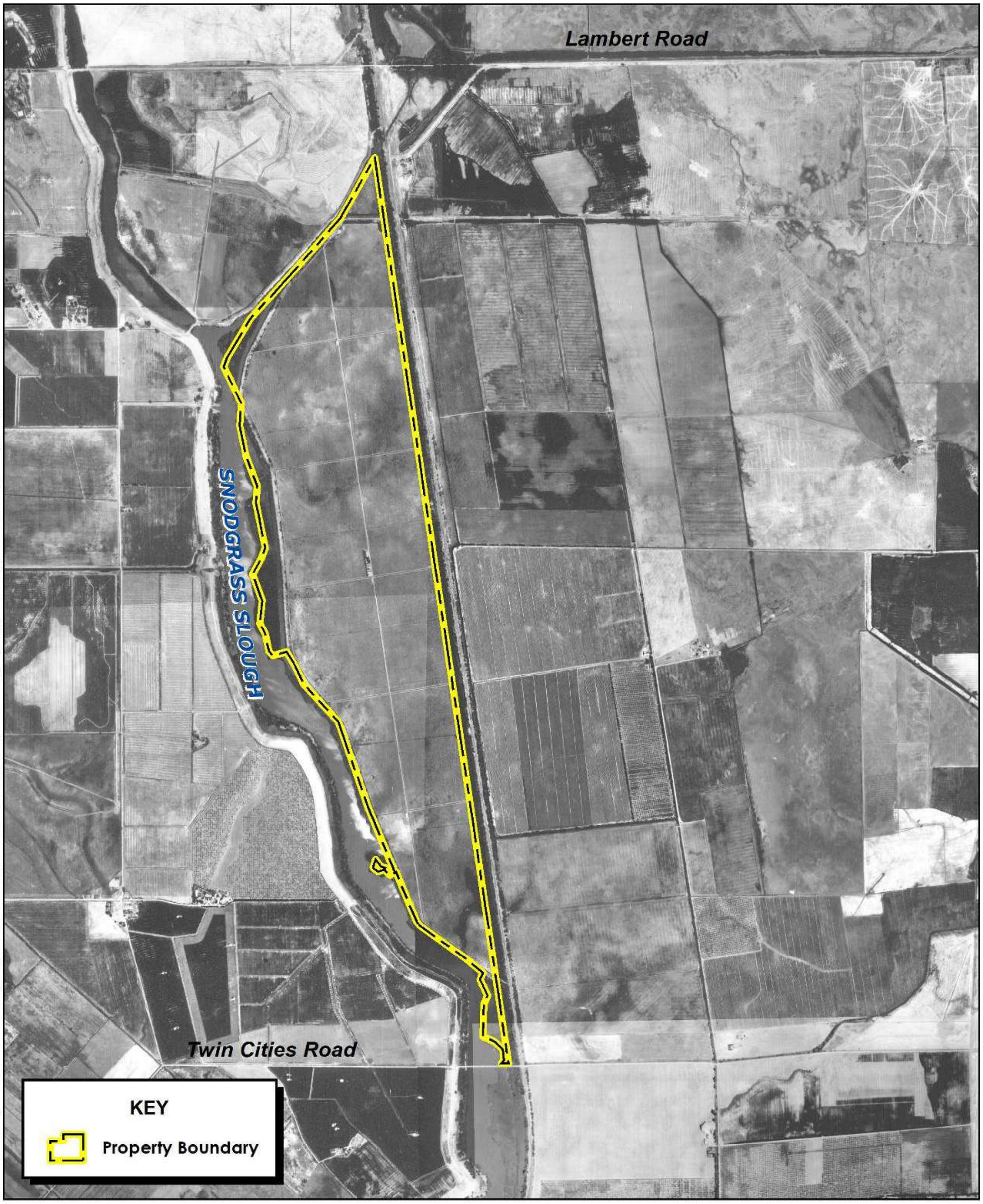
FIGURE 13
Property Encumbrances



M. Lozano: G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_14_ZR_Current_Aerial_Photo_June2021_2021_1203.mxd

Source:
Google Earth Imagery
June 2021

FIGURE 14
Current Aerial Photo
June 2021

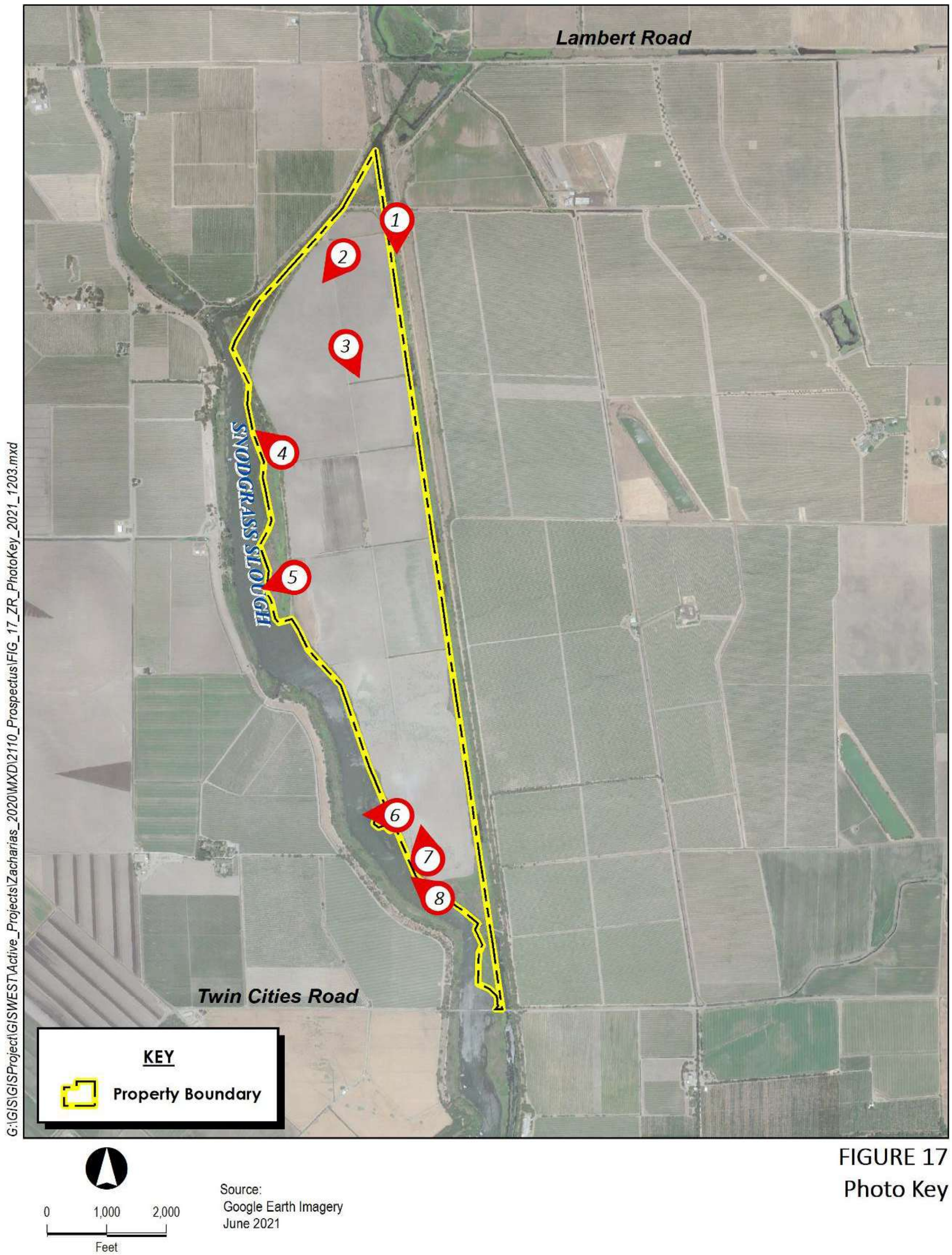


G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_16_ZR_Historical_Aerial_Photo_1937_2021_1203.mxd

0 1,000 2,000
Feet

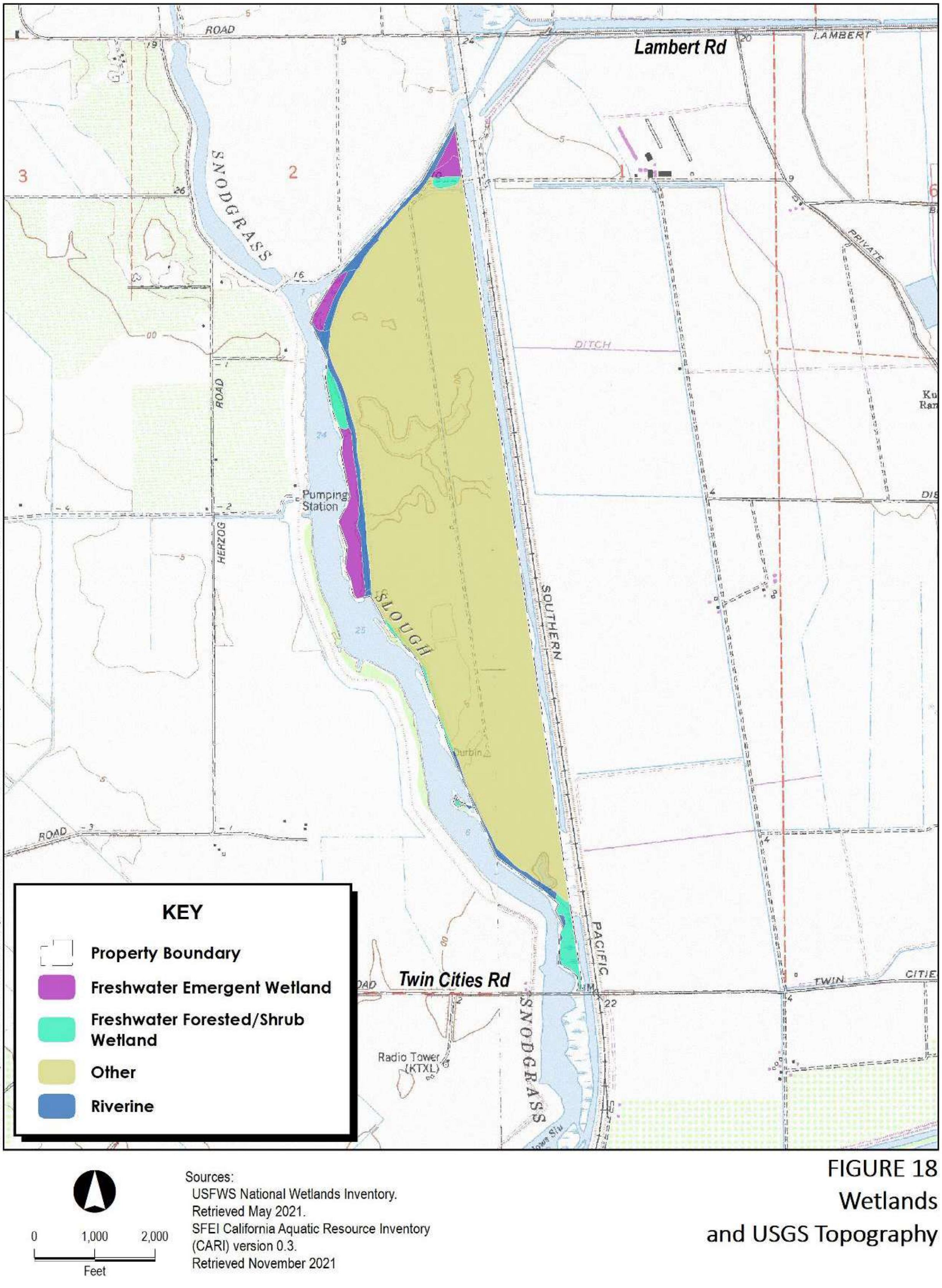
Source:
USDA Agriculture Adjustment Administration, 1937.

FIGURE 16
Historic Aerial Photo
1937



Source:
Google Earth Imagery
June 2021

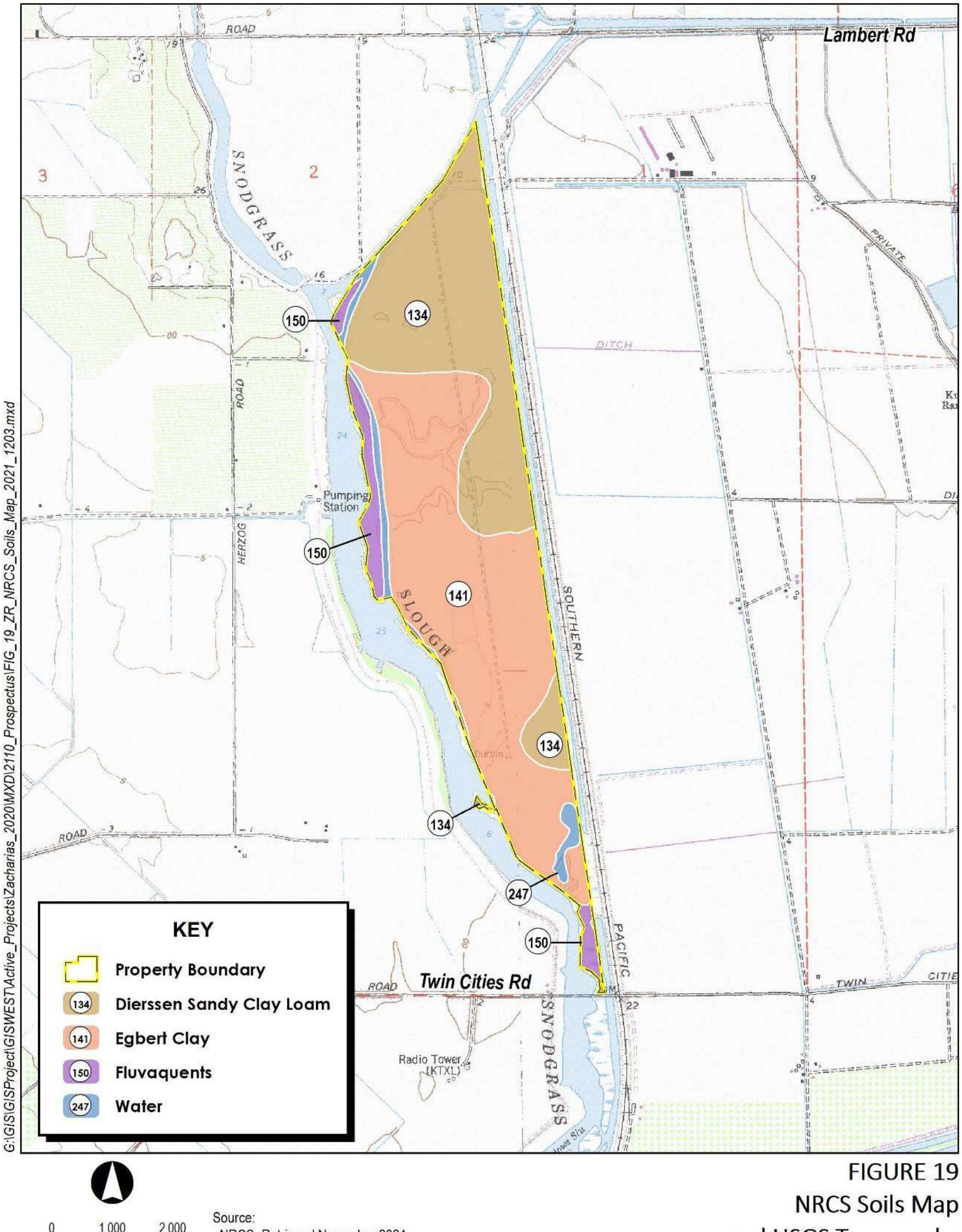
FIGURE 17
Photo Key



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_18_ZR_Wetlands_2021_1203.mxd

Sources:
USFWS National Wetlands Inventory. Retrieved May 2021.
SFEI California Aquatic Resource Inventory (CARI) version 0.3. Retrieved November 2021

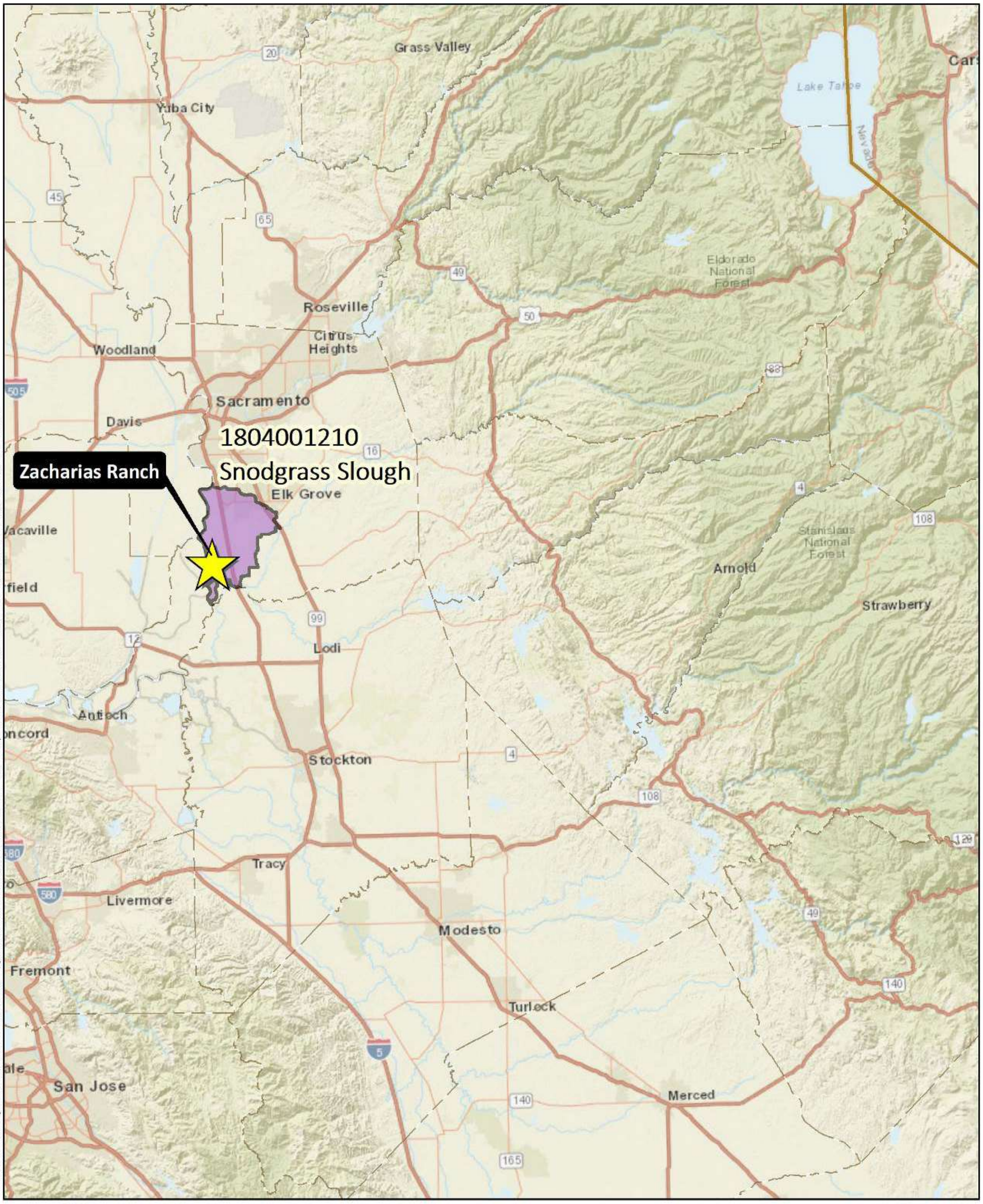
FIGURE 18
Wetlands
and USGS Topography



Source:
NRCS. Retrieved November 2021.

FIGURE 19
NRCS Soils Map
and USGS Topography

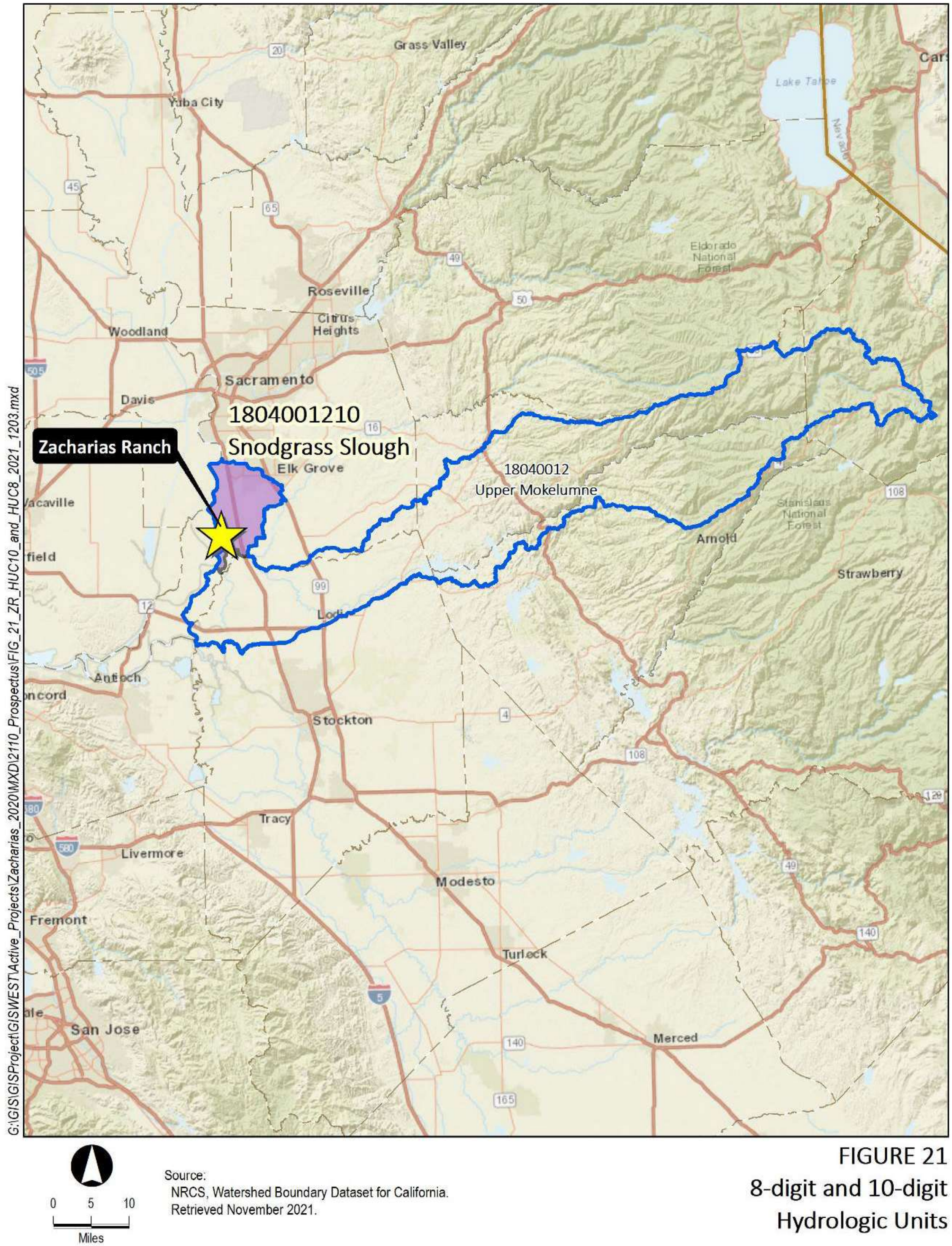
G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_20_ZR_HUC10_Watershed_2021_1203.mxd



0 5 10
Miles

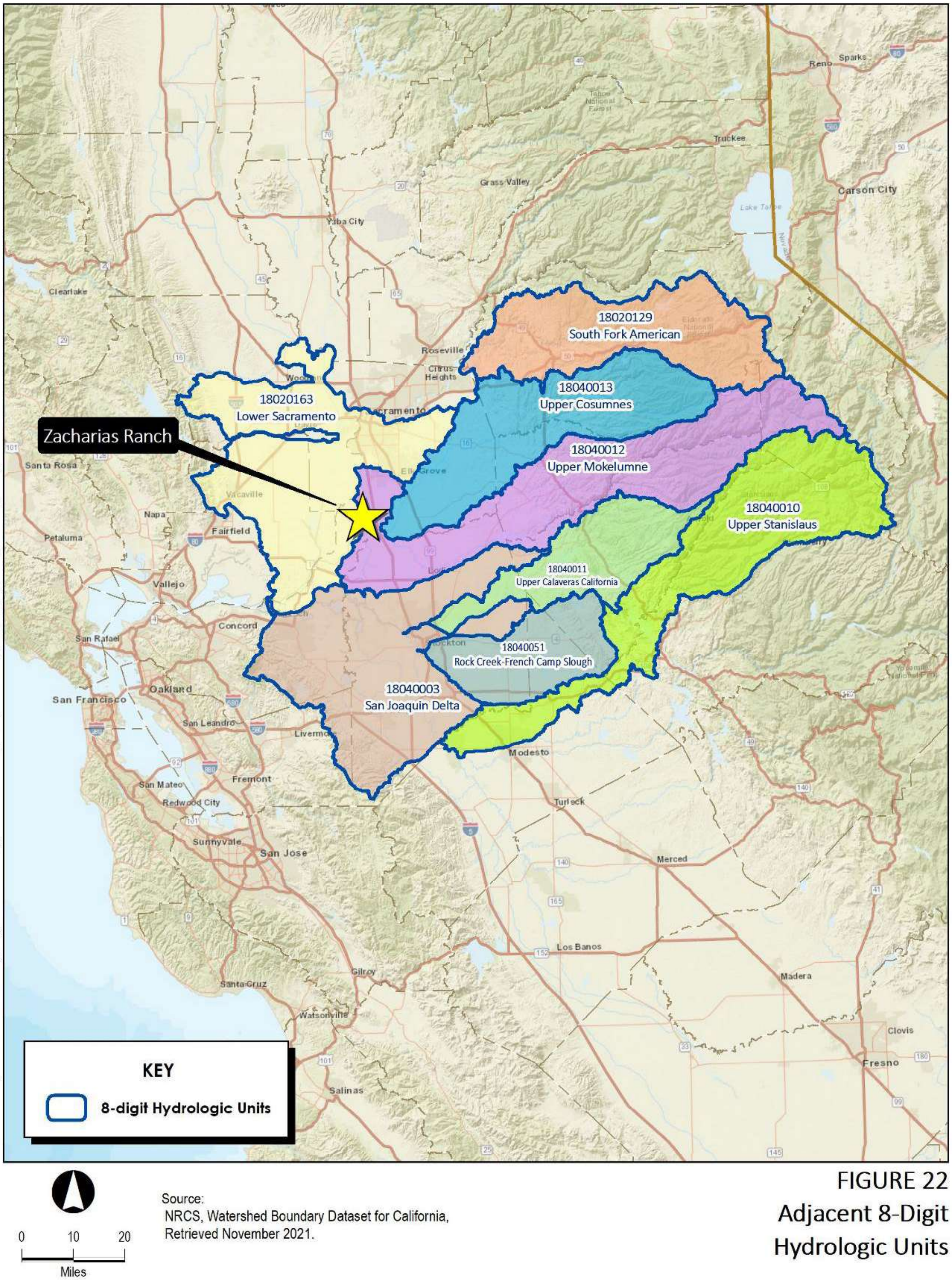
Source:
NRCS, Watershed Boundary Dataset for California.
Retrieved November 2021.

FIGURE 20
10-digit Hydrologic Unit



Source:
NRCS, Watershed Boundary Dataset for California.
Retrieved November 2021.

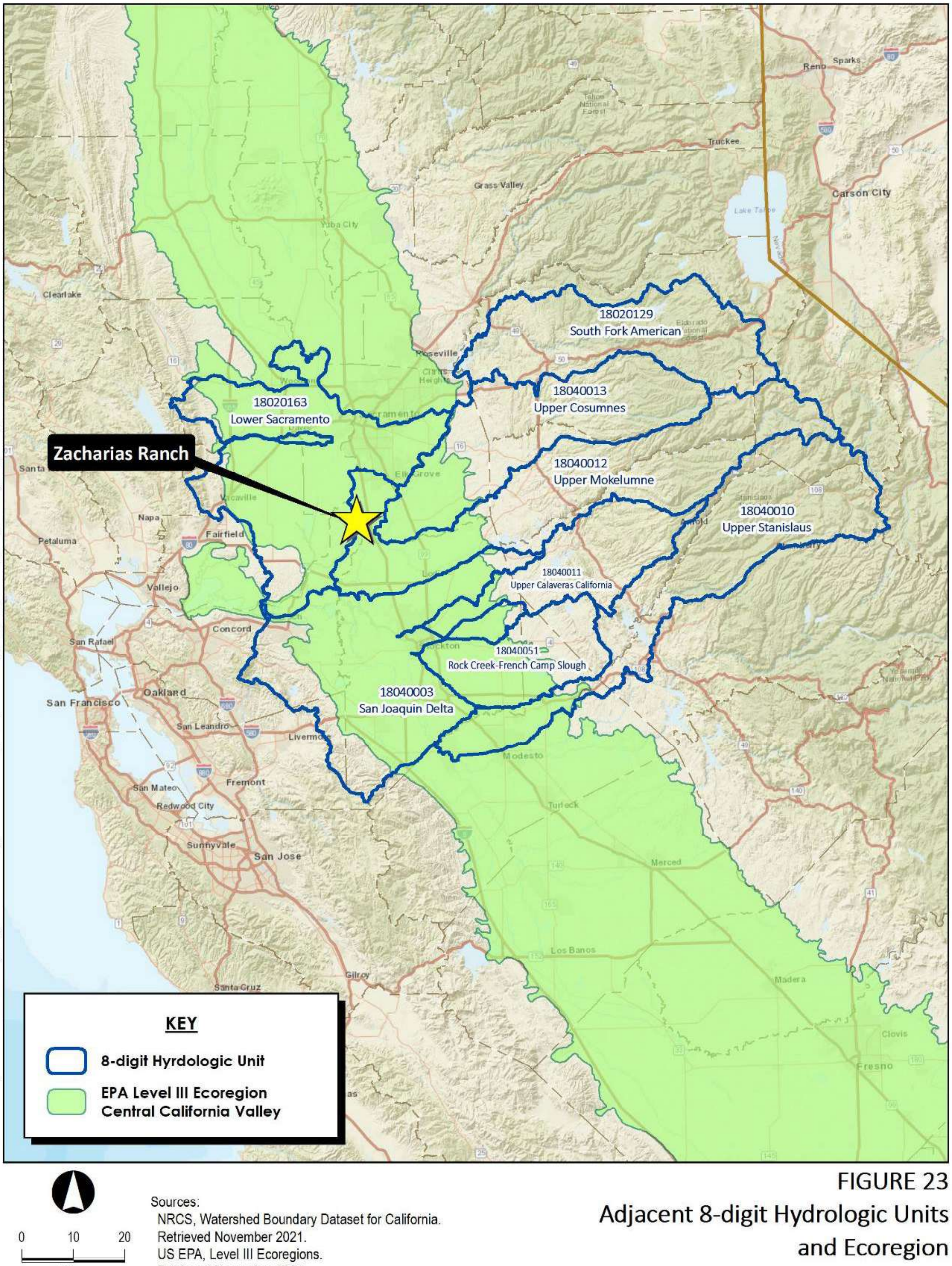
FIGURE 21
8-digit and 10-digit
Hydrologic Units



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_22_ZR_Adjacent_HUC8s_2021_1203.mxd

Source:
NRCS, Watershed Boundary Dataset for California, Retrieved November 2021.

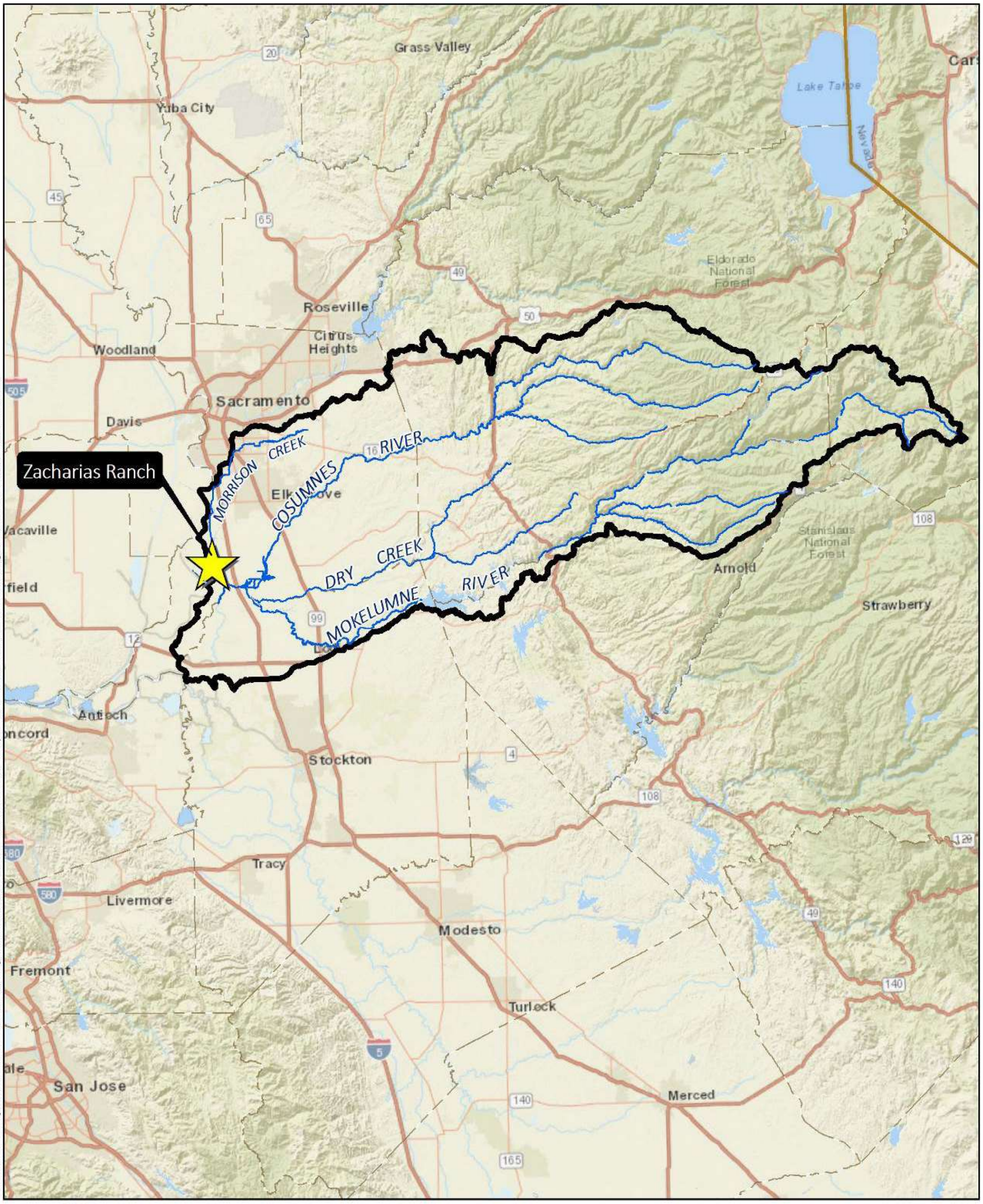
FIGURE 22
Adjacent 8-Digit Hydrologic Units



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_23_ZR_HUC8s_and_EcoRegion_2021_1203.mxd

Sources:
NRCS, Watershed Boundary Dataset for California.
Retrieved November 2021.
US EPA, Level III Ecoregions.
Retrieved November 2021.

FIGURE 23
Adjacent 8-digit Hydrologic Units
and Ecoregion

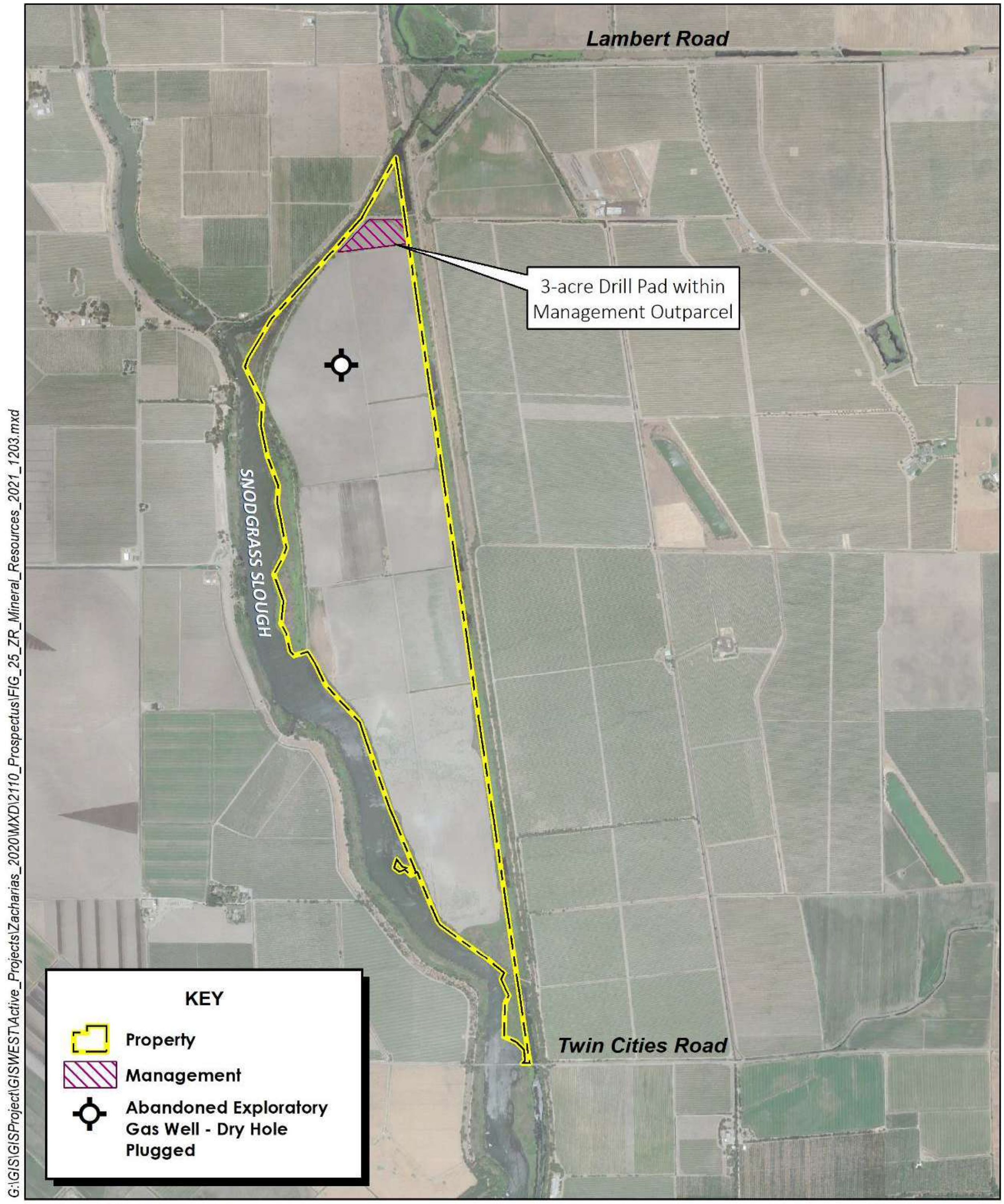


G:\GIS\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_24_ZR_Contributing_Watersheds_2021_1203.mxd

0 5 10
Miles

Source:
NRCS, Watershed Boundary Dataset for California.
Retrieved November 2021.

FIGURE 24
Contributing Watersheds

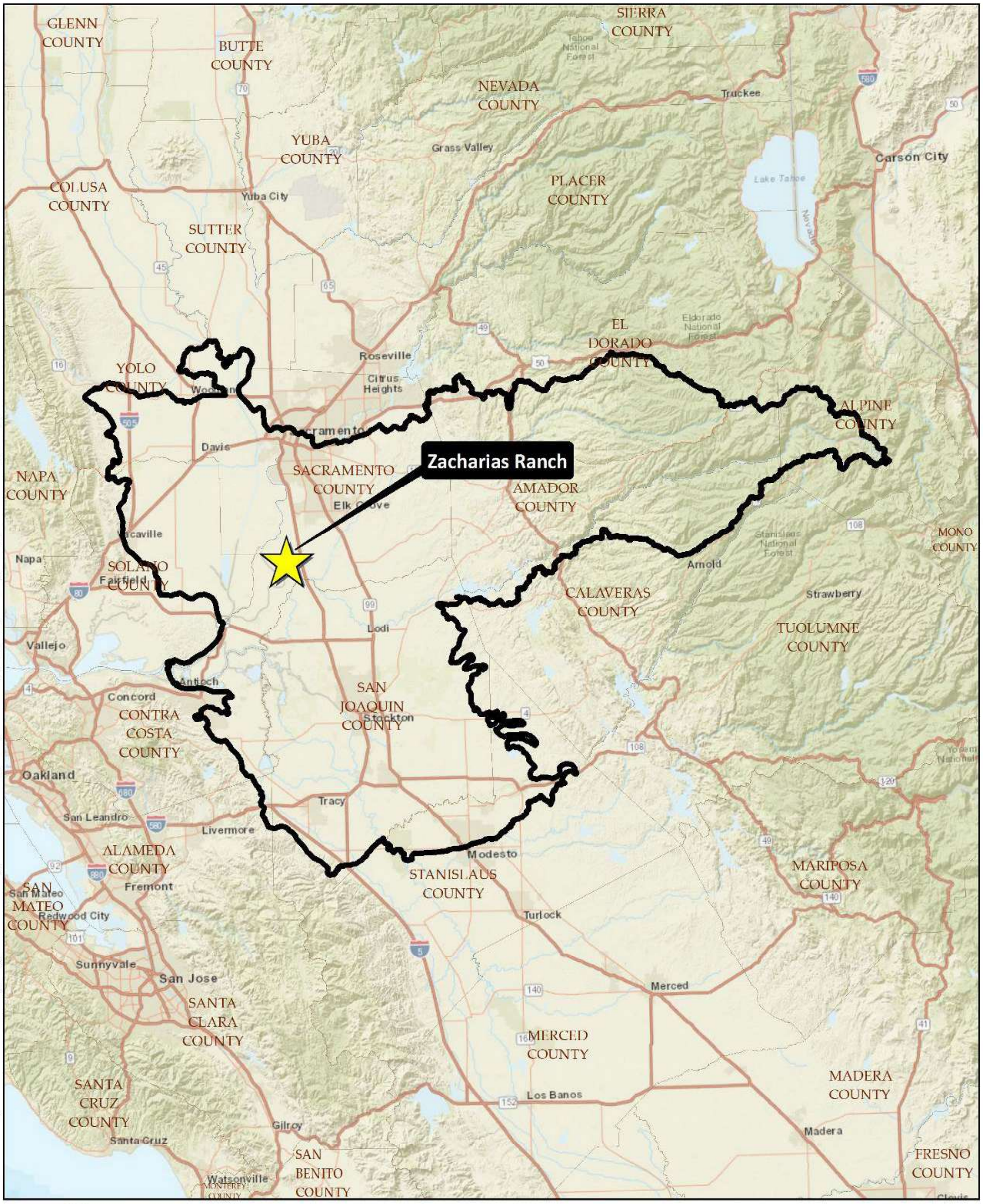


0 1,000 2,000
Feet

Source:
CalGEM. Retrieved November 2021.

FIGURE 25
Mineral Resources

G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_26_ZR_Service_Area_404Wetlands_2021_1203.mxd



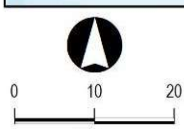
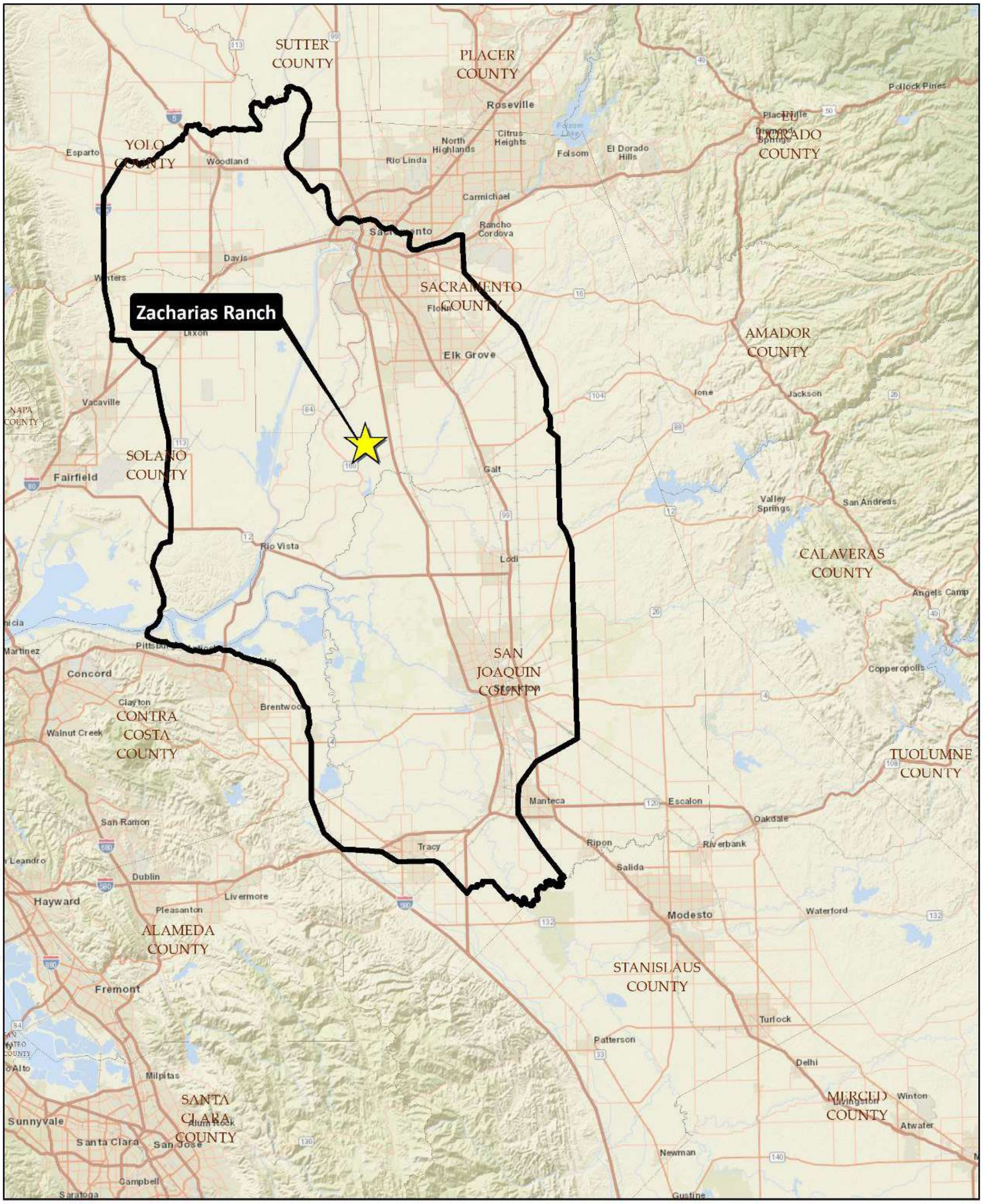


FIGURE 26
404 Wetlands Service Area

G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_27_ZR_Service_Area_GGS_2021_1203.mxd



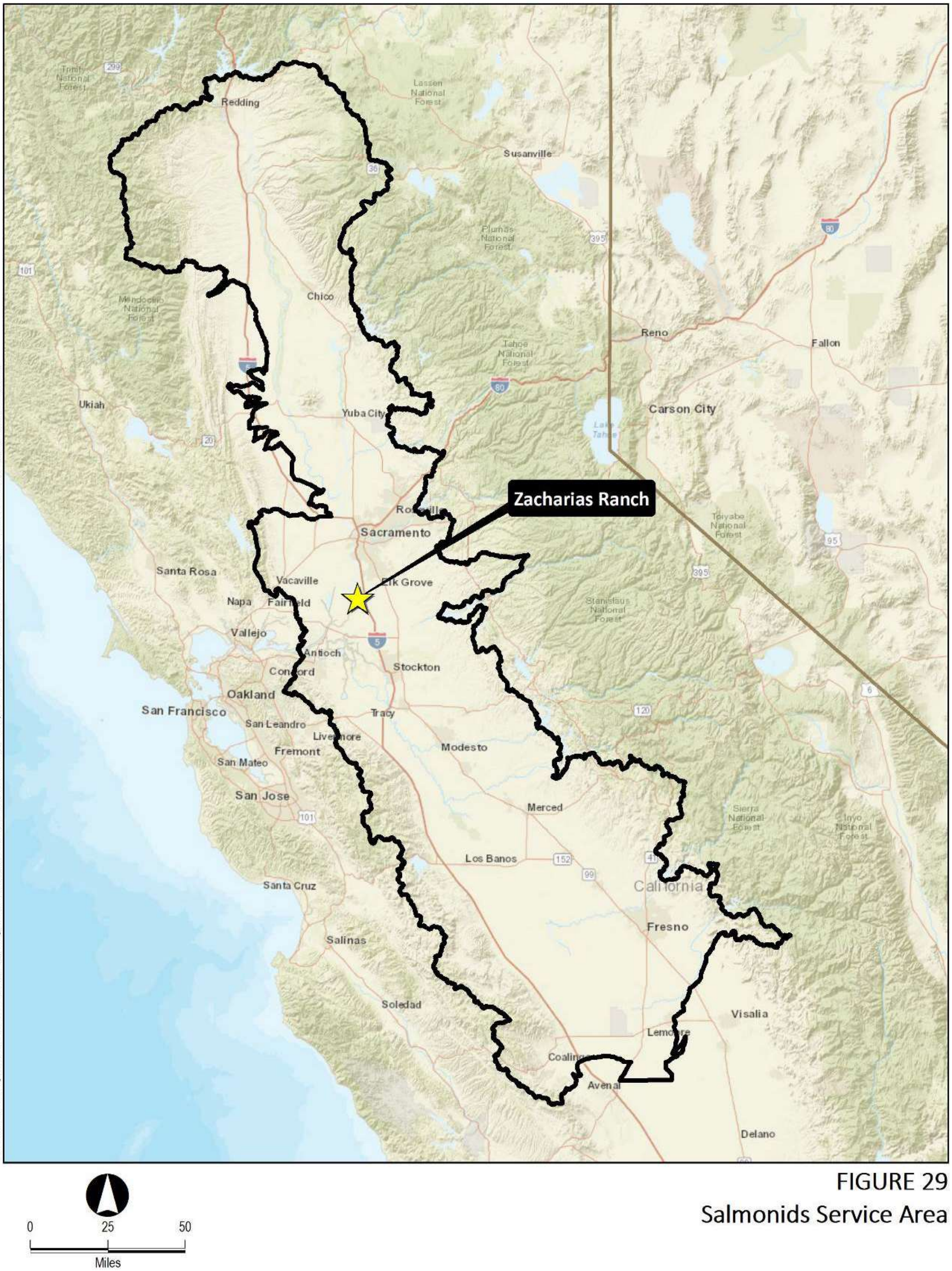
0 5 10
Miles

FIGURE 27
Giant Garter Snake
Service Area

G:\GIS\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_28_ZR_Service_Area_Green_Sturgeon_2021_1203.mxd

0 10 20
Miles

FIGURE 28
Green Sturgeon
Service Area



G:\GIS\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_29_ZR_Service_Area_Salmonids_2021_1203.mxd

FIGURE 29
Salmonids Service Area

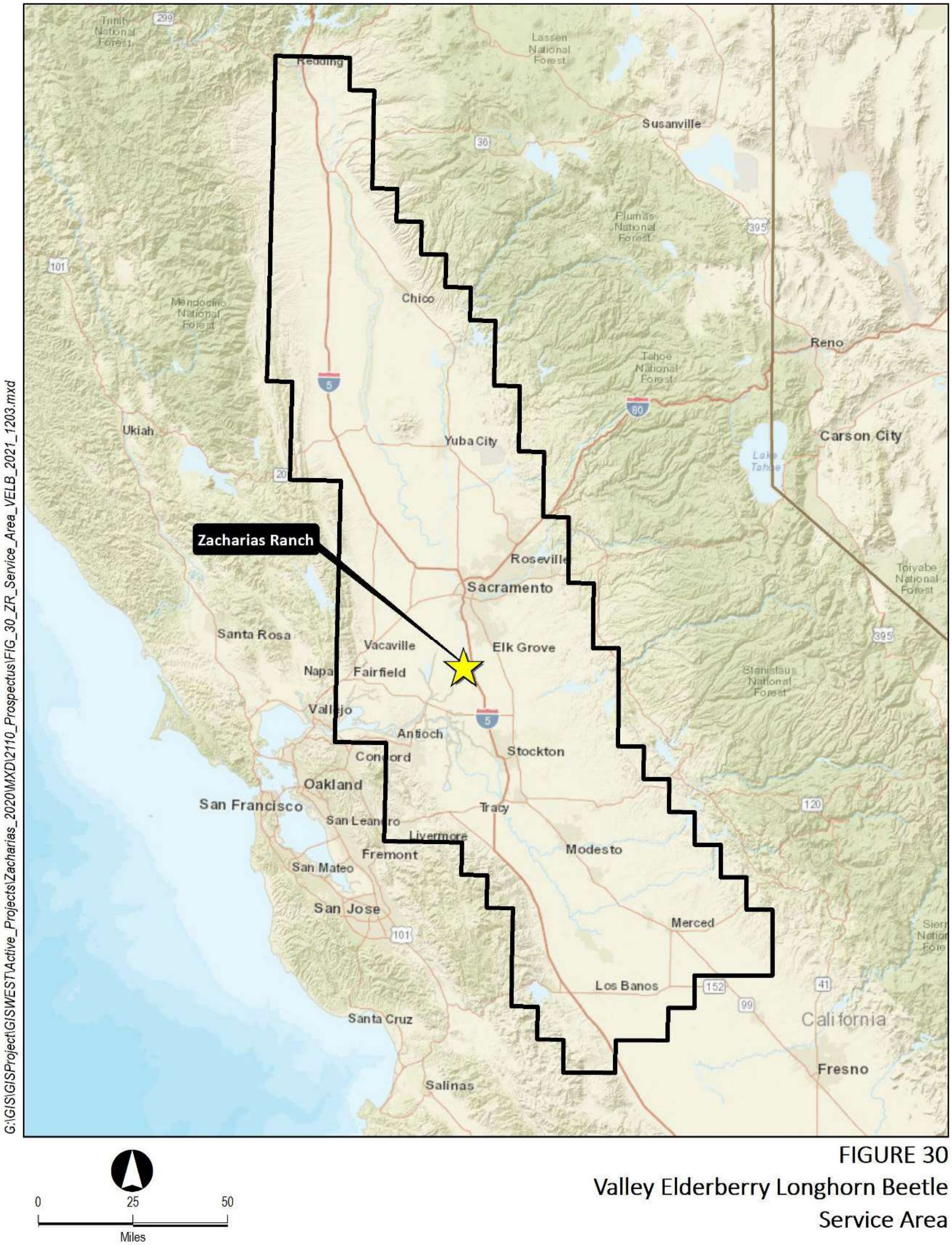
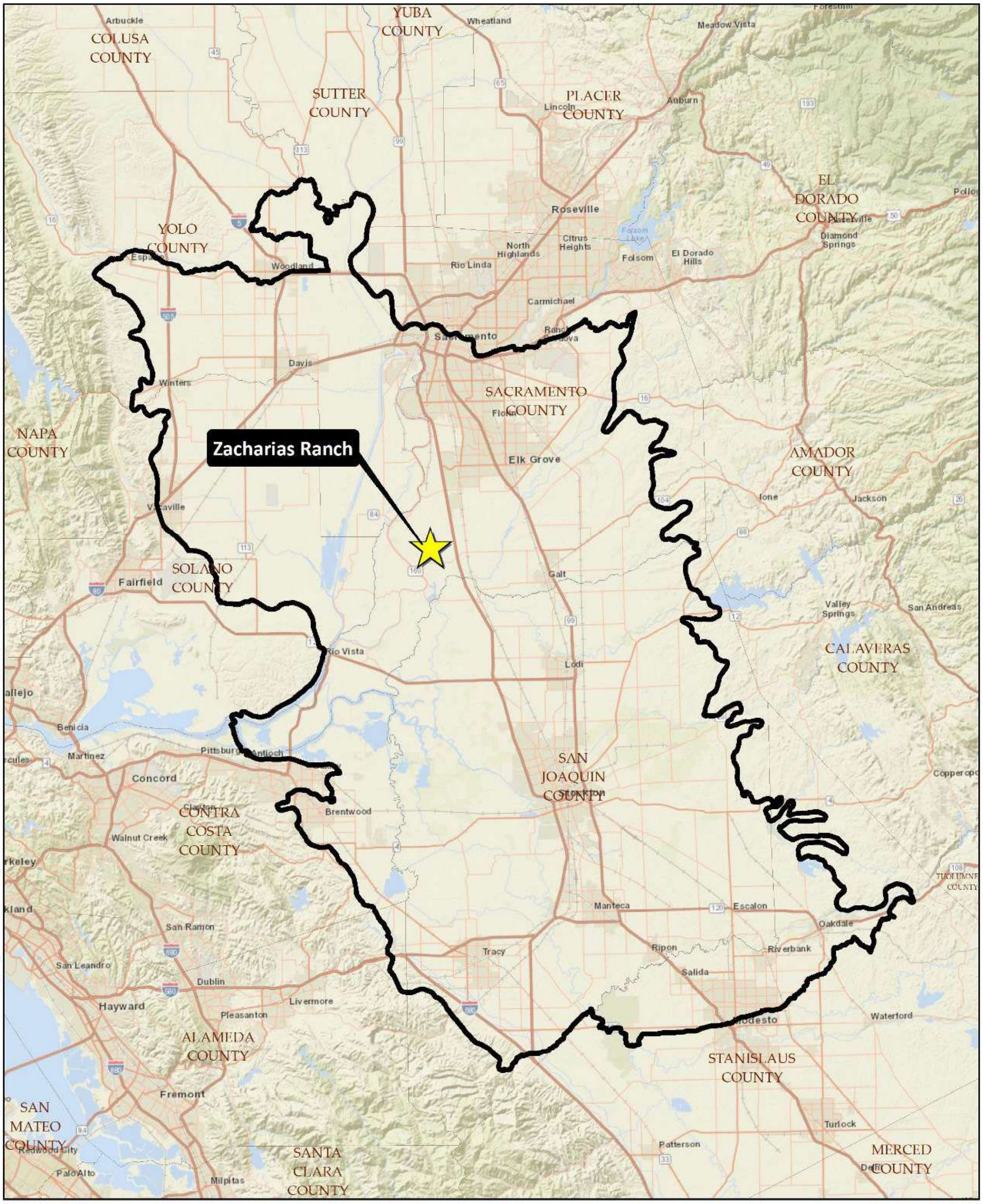


FIGURE 30
Valley Elderberry Longhorn Beetle
Service Area



G:\GIS\GISProject\GISWEST\Active_Projects\Zacharias_2020\MXD\2110_Prospectus\FIG_31_ZR_Service_Area_SWHawk_2021_1203.mxd

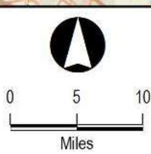


FIGURE 31
Swainson's Hawk
Service Area

Appendix E
Proposed Mitigation
Sequencing

	LSJRP, San Joaquin River West Mitigation Site Completed Physical Construction **Aug-25**	LSJR, TS-30L Levee Improvement Commence Levee Improvement Construction **Aug-24**						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	41.65	11.90	0					
Wetland (Also GGS aquatic habitat)			0					
Grassland (Also GGS Upland)			0					
SRA (LF) (Steelhead, Sturgeon, Salmonid)	0.00	0.00	0					
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	0.00	0					
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	0.00	0					

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

In addition 3.7 acre equivalent credits of GGS habitat will be purchased from a conservation bank

	LSJRP, Phase A- 14mi Pump Station Mitigation Site Completed Physical Construction **Aug-26**	LSJR, Phase A- Levee Improvement (ST10R, ST20R, FS10R) Commence Levee Improvement Construction **May-28**						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	63.22	20.75	11.35	2.50	51.875			
Wetland (Also GGS aquatic habitat)	7.36	2.40	1.36	2.50	6			
Grassland (Also GGS Upland)	0.00	0.00	0.00	2.50	0			
SRA (LF) (Steelhead, Sturgeon, Salmonid)	0.00	0.00	0.00	2.50	0			
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	0.00	0.00	2.50	0			
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	0.00	0.00	2.50	0			

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

Assumes a 2.5:1 mitigation ratio based on FWCA Report for TS-30L

Habitat impact estimates include the remainder of Delta Front Reach excluding TS-30L

	LSJRP, Phase F- "In and On River" Mitigation Sites Completed Physical Construction **Aug-28**	LSJR, Phase F- Levee Improvement (MC10L, MC20L) Commence Levee Improvement Construction **May-32**						
	Acres of Habitat Improved / Preserved	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	85.00	[11.35] 21.5	53.35	2.00	21.50	43.00	96.35	53.35
Wetland (Also GGS aquatic habitat)	22.00	[1.36] 3	17.36	2.00	3.00	6.00	23.36	17.36
Grassland (Also GGS Upland)	5.00	0	5	2.00	-	-	5.00	5.00
SRA (LF) (Steelhead, Sturgeon, Salmonid)	21,500.00	0	21,500	2.00	-	-	21,500.00	21,500.00
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	13.00	0	13	2.00	-	-	13.00	13.00
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	5.00	0	5	2.00	-	-	5.00	5.00

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

Assumes 2:1 ratio due to limit in uplift potential at mitigation sites

	LSJRP, Phase C- Calaveras River Sites Completed Physical Construction **Aug-29**	LSJR, Phase C-2- Calaveras Levee Improvement (CR10R, CR80R) Commence Levee Improvement Construction **Aug-31**						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	40.00	[53.35] 52	(10.65)	2.00	52.00	104.00	93.35	(10.65)
Wetland (Also GGS aquatic habitat)	-	[17.36] 1.75	13.86	2.00	1.75	3.50	17.36	13.86
Grassland (Also GGS Upland)	-	[5] 0	5.00	2.00	-	-	5.00	5.00
SRA (LF) (Steelhead, Sturgeon, Salmonid)	11,000.00	[21,500] 7,804	16,892.00	2.00	7,804.00	15,608.00	32,500.00	16,892.00
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	-	[13] 0	13.00	2.00	-	-	13.00	13.00
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	-	[5] 0	5.00	2.00	-	-	5.00	5.00

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting
Depending on site design specifics, portions of the Calaveras River compensation sites may be considered "on-site" restoration and would need to be completed following levee work
Includes impacts for all of Calaveras River which is an overestimate

	LSJRP, Phase C-1- Manteca Mitigation Site Completed Physical Construction Aug-30	LSJR, Phase C-1- Ten Mile Slough Levee Improvement (TS10L, TS20L) Commence Levee Improvement Construction Aug-31						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	140.00	[-10.65] 16.87	57.44	3.00	27.52	82.56	140.00	57.44
Wetland (Also GGS aquatic habitat)	-	[13.86] 4	1.86	3.00	4	12	13.86	1.86
Grassland (Also GGS Upland)	-	[5] 0	5.00	3.00	0	0	5.00	5.00
SRA (LF) (Steelhead, Sturgeon, Salmonid)	28,450.00	[16,892.00] 0	16,892.00	3.00	0	0	16,892.00	16,892.00
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	6.50	[13.00] 0	19.50	3.00	0	0	19.50	19.50
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	-	[5] 0	5.00	3.00	0	0	5.00	5.00

values in [ ] indicate a carryover "bank" balance from a previous phase
Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.
Completed physical construction is defined as completion of earthwork and planting
Impacts are assumed to be the remainder of impacts for Delta Front excluding those already considered for TS-30L
Impacts for the closure structure at 14 Mile Slough were placed under Phase B

	LSJRP, Phase B- On site Completed Physical Construction Aug-33	LSJR, Phase B- 14 Mile Slough Setback Levee Improvement (FM30L, FM40L, FM60L) Commence Levee Improvement Construction Feb-33						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	14.00	[57.44] 0	71.44	2.00	-	-	71.44	71.44
Wetland (Also GGS aquatic habitat)	-	[1.86]	1.86	2.00	-	-	1.86	1.86
Grassland (Also GGS Upland)	-	[5.00] 8.87	(12.74)	2.00	8.87	17.74	5.00	(12.74)
SRA (LF) (Steelhead, Sturgeon, Salmonid)	-	[16,892.00]	16,892.00	2.00	-	-	16,892.00	16,892.00
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	-	[19.50]	19.50	2.00	-	-	19.50	19.50

Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	-	[5]	5.00	2.00	-	-	5.00	5.00

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

Construction of the 14 Mile Setback Compensation site requires the levee work to be completed first

Effects to Delta Smelt due to operation of the closure structure would be mitigated through credit purchases

All other habitat impacts from Fourteen Mile Slough segments besides grassland were accounted for under Delta Front (Phase A)

	LSJRP, Phase E- Van Buskirk Site Completed Physical Construction Aug-38	LSJR, Phase E- Levee Improvement (SJR30R-SJR70R, FCS 10R, DC10R-DC30R) Commence Levee Improvement Construction Feb-35						
	Acres of Habitat Created	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)	27.00	[71.44] 32.75	32.94	2.00	32.75	65.50	98.44	32.94
Wetland (Also GGS aquatic habitat)	9.75	[1.86] 2	7.61	2.00	2.00	4.00	11.61	7.61
Grassland (Also GGS Upland)	12.00	[-12.74] 35.12	-70.98	2.00	35.12	70.24	(0.74)	(70.98)
SRA (LF) (Steelhead, Sturgeon, Salmonid)	9600.00	[16,892.00] 11826.00	2840.00	2.00	11,826.00	23,652.00	26,492.00	2,840.00
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	[19.50] 0	19.50	2.00	-	-	19.50	19.50
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)	0.00	[5] 1	3.00	2.00	1.00	2.00	5.00	3.00

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

Construction of the Van Buskirk Compensation site requires the levee work to be completed first

	Complete Remaining Need with Credits or On-site Opportunities	LSJR, Phase D- Calaveras Left Bank Levee Improvement (SJR10R, CR10L-CR70L) Commence Levee Improvement Construction Jun-35						
	Acres of Habitat to Purchase	Acres of Habitat Removed	Net Difference	Estimated Ratio	Acres impacted	Total Impact	Sum of Habitat created	Net difference
Riparian (Also VELB habitat)		-						
Wetland (Also GGS aquatic habitat)		-						
Grassland (Also GGS Upland)	70.98	-	-					

SRA (LF) (Steelhead, Sturgeon, Salmonid)		-	
Shallow Water (Smelt, Steelhead, Sturgeon, Salmonid)		-	
Open Water (Smelt, Steelhead, Sturgeon, Salmonid)		-	

values in [ ] indicate a carryover "bank" balance from a previous phase

Commencement of Levee improvement construction is defined as "first impact" tree removal, grubbing, staging etc.

Completed physical construction is defined as completion of earthwork and planting

Impacts for the entire Calaveras River were included under Phase C-2

APPENDIX B

Table: Summary of CEQA Impacts and Mitigation Measures

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
3.3.2 Aesthetics			
Development of CMP-covered mitigation sites could have a substantial effect on a scenic vista; substantially damage scenic resources; substantially degrade the existing visual character of public views of the site; and/or create a new source of substantial light or glare.	PS	**Mitigation Measure 3.6-16** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-17** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-18** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-19** (See text under Impact VW-1, VW-2, VW-3, and VW-4)	Consistent with previous EIRs (SU)
3.3.2 Agricultural and Forestry Resources			
Development of CMP-covered mitigation sites could convert Prime Farmland, Unique Farmland, or Farmland of Statewide Importance (Special Designated Farmland) to non-agricultural use, or conflict with existing zoning for agricultural use or a Williamson Act contract	LTS	**None required.**	NA
3.3.2 Air Quality			
Development of CMP-covered mitigation sites could result in a cumulatively considerable net increase of any criteria air pollutant for which the region is in nonattainment; generate GHG emissions that may have a significant impact on the environment; conflict with or obstruct implementation of the applicable air quality plan or an applicable plan, policy or regulation adopted for reducing the emissions of GHGs; expose sensitive receptors to substantial pollutant concentrations; or create objectionable odors.	PS	**Mitigation Measure 3.2.2-1: Reduce Construction-Related NO_X Emissions.** The mitigation measure for Alternative 7a outlined in Section 5.8.10 of the 2018 LSJR FR/EIS/EIR shall be applied to the development of CMP-covered mitigation sites: USACE shall require the use of off-road equipment that meets or exceeds USEPA or California Air Resources Board CARB Tier 4 off-road emission standards for all off-road vehicles greater than 25 horsepower and operating for more than 20 total hours over the entire duration of construction activities. Prior to issuance of a construction permit, the prime contractor(s) shall prepare and submit a Construction Emissions Minimization Plan (Plan) to USACE for review and approval. The Plan shall include estimates of the construction timeline by phase with a description of each piece of equipment required for every construction phase. Equipment descriptions and information shall include: equipment type, equipment manufacturer, equipment identification number, engine model year, engine certification (Tier rating), horsepower, engine serial number and expected fuel usage and hours of operation. The Plan shall be	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		kept by USACE and made available for review by any persons requesting it. Quarterly reports shall be submitted by the prime contractor(s) to USACE indicating the construction phase and equipment information used during each phase for the previous quarter.	
3.3.2 Energy			
Development of CMP-covered mitigation sites could result in a potentially significant environmental impact due to wasteful, inefficient, or unnecessary consumption of energy resources, during project construction or operation or conflict with or obstruct a state or local plan for renewable energy or energy efficiency.	LTS	**None required.**	NA
3.3.2 Geology and Geomorphology, Seismicity, Soils and Mineral Resources, Paleontological Resources			
Development of CMP-covered mitigation sites could substantially alter regional geologic or local geomorphologic resources or processes; substantially alter natural river meandering, bank erosion and deposition; expose people or structure to potential substantial adverse effects involving rupture of a known earthquake fault or seismic-related ground failure; result in substantial erosion of soil or loss of topsoil; be located on expansive soil; have soils incapable of adequately supporting the use of septic tanks or alternative wastewater disposal systems; result in the loss of availability of known mineral resources.	LTS	**None required.**	NA
Development of CMP-covered mitigation sites could directly or indirectly destroy a unique	PS	**Mitigation Measure 3.7-4: Preconstruction Training and Paleontological Monitoring.** Prior to the start of construction activities, USACE shall retain a Qualified Paleontologist who meets the standards of the Society for Vertebrate Paleontology (SVP 2010) to carry out all mitigation measures related to paleontological resources. Prior to the start of any ground-disturbing activities, the Qualified Paleontologist shall conduct	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
paleontological resource or site or unique geologic feature.		preconstruction worker paleontological resources sensitivity training. The training shall include information on what types of paleontological resources could be encountered during excavations, what to do in case an unanticipated discovery is made by a worker, and laws protecting paleontological resources. All construction personnel shall be informed of the possibility of encountering fossils and instructed to immediately inform the construction foreman or supervisor if any bones or other potential fossils are unexpectedly unearthed in an area where a paleontological monitor is not present. The Applicant shall ensure that construction personnel are made available for and attend the training and retain documentation demonstrating attendance. The Qualified Paleontologist shall supervise a paleontological monitor meeting the Society for Vertebrate Paleontology standards (SVP 2010) who shall be present during all excavations in the Modesto Formation. Monitoring shall consist of visually inspecting fresh exposures of rock for larger fossil remains and, where appropriate, collecting wet or dry screened standard sediment samples (up to 4.0 cubic yards) of promising horizons for smaller fossil remains (SVP 2010). Depending on the conditions encountered, full-time monitoring can be reduced to part-time inspections or ceased entirely if determined adequate by the Qualified Paleontologist. The Qualified Paleontologist may spot check the excavation on an intermittent basis and recommend whether the depth of required monitoring should be revised based on his/her observations. Monitoring activities shall be documented in a Paleontological Resources Monitoring Report to be prepared by the Qualified Paleontologist at the completion of construction. If a paleontological resource is discovered during construction, the paleontological monitor shall be empowered to temporarily divert or redirect grading and excavation activities in the area of the exposed resource to facilitate evaluation of the discovery. An appropriate buffer area shall be established by the Qualified Paleontologist around the find where construction activities shall not be allowed to continue. Work shall be allowed to continue outside of the buffer area. All significant fossils shall be collected by the paleontological monitor and/or the Qualified Paleontologist. Collected fossils shall be prepared to the point of identification and catalogued before they are submitted to their final repository. Any fossils collected shall be curated at a public, non-profit institution with a research interest in the materials, such as the University of California Museum of Paleontology at Berkeley, if such an institution agrees to accept the fossils. If no institution accepts the fossil collection, they shall be donated to a local school in	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		the area for educational purposes. Accompanying notes, maps, photographs, and a technical report shall also be filed at the repository and/or school.	
3.3.2 Greenhouse Gas Emissions			
Development of CMP-covered mitigation sites could generate greenhouse gas emissions, either directly or indirectly, that may have a significant impact on the environment or conflict with an applicable plan, policy or regulation adopted for the purpose of reducing the emissions of greenhouse gases.	LTS	**None required.**	NA
3.3.2 Hydrology and Hydraulics			
Development of CMP-covered mitigation sites could substantially alter the existing drainage patterns of the site in a manner that would result in substantial erosion or siltation; create or contribute runoff water that would exceed the capacity of existing or planned stormwater drainage systems or provide substantial additional sources of polluted runoff; place housing or other structures that would impede or redirect flood flows within a 1 percent annual chance exceedance (ACE) special flood hazard area; or expose people or structures to a significant risk of loss, injury or death involving flooding.	LTS	**None required.**	NA
3.3.2 Noise and Vibration			
Construction activities associated with development of CMP-covered mitigation sites could lead to a temporary increase in ambient noise levels in the vicinity of the CMP-covered mitigation sites in excess of standards established	PS	**Mitigation Measure 3.10-1: Construction Noise Reduction.** The following measures shall be implemented to reduce the effects of construction under development of the CMP-covered mitigation sites: • The contractor shall prepare a construction noise and vibration plan prior to construction.	Consistent with previous EIRs (SU)

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
in the local General Plan or noise ordinance, or applicable standards of other agencies or generate excessive groundborne vibration or groundborne noise levels in the vicinity of the CMP-covered mitigation sites.		• The contractor shall employ vibration-reducing construction practices. • The contractor shall employ noise-reducing construction practices. • All construction equipment shall be equipped with noise-reduction devices such as mufflers to minimize construction noise and all internal combustion engines shall be equipped with exhaust and intake silencers in accordance with manufacturers' specifications. • Equipment that is quieter than standard shall be used, including electrically powered equipment instead of internal combustion equipment, where use of such equipment is a readily available substitute that accomplishes project tasks in the same manner as internal combustion equipment. • The use of bells, whistles, alarms, and horns shall be restricted to safety warning purposes only. • Noise-reducing enclosures shall be used around stationary noise-generating equipment (e.g., compressors and generators at slurry pond locations). • Mobile and fixed construction equipment (e.g., compressors and generators), construction staging and stockpiling areas and construction vehicle routes shall be located at the most distant point feasible from noise-sensitive receptors. • When noise-sensitive uses subject to prolonged construction noise are located within 740 feet of construction in Stockton or unincorporated areas of San Joaquin County, noise-attenuating buffers such as structures, truck trailers, or soil piles shall be located between noise-generation sources and sensitive receptors. • Before construction activity begins within 740 feet of one or more residences or businesses, the project proponent shall provide written notification to the potentially affected residents or business owners, identifying the type, duration, and frequency of construction activities. The USACE resident engineer and contractor's project manager shall be designated and contact information shall be provided in the notices and posted near the project area in a conspicuous location that it is clearly visible to nearby receptors most likely to be disturbed. The USACE resident engineer shall manage complaints and concerns resulting from noise-generating activities. The severity of the noise concern shall be assessed by the noise disturbance coordinator and, if necessary, evaluated by a qualified noise control engineer. • The project proponent shall ensure that all heavy trucks are properly maintained and equipped with noise control devices (e.g., muffler) in accordance with manufacturers'	

Table 2
Summary of CEQA Impacts and Mitigation Measures

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		specifications at each work site during project construction to minimize construction traffic noise effects on sensitive receptors. • Before haul truck trips are initiated during construction season on roads within 90 feet of residences located along haul routes, written notification shall be provided to potentially affected residents identifying the hours and frequency of haul truck trips. Notifications provide contact information for the USACE resident engineer identified above and also identify a mechanism for residents to register complaints with the appropriate jurisdiction if haul truck noise levels are overly intrusive or occur outside the exempt daytime hours for the applicable jurisdiction.	
3.3.2 Hazards, Hazardous Materials and Public Safety			
Development of CMP-covered mitigation sites could create a significant hazard to the public or the environment through the routine transport, use, or disposal of hazardous materials or through reasonably foreseeable upset and accident conditions involving the release of hazardous materials into the environment; emit hazardous emissions or involve the handling of hazardous or acutely hazardous materials within one-quarter mile of a school; or be located within a Hazardous, Toxic, and Radioactive Waste (HTRW) site.	PS	**Mitigation Measure 3.2.4-1: Reduce Hazards Associated with Potential Exposure to Hazardous Substances.** The mitigation measures for Alternative 7a outlined in Section 5.20.10 of the 2018 LSJR FR/EIS/EIR have been slightly modified and shall be applied to the development of CMP-covered mitigation sites: The following measures would be implemented before ground-disturbing or demolition activities begin, in order to reduce health hazards associated with potential exposure to hazardous substances: • Complete a Phase I Environmental Site Assessment (ESA) prior to completing preconstruction designs and initiating construction. Where construction activities would occur in close proximity to sites identified as Recognized Environmental Conditions in the Phase I ESA, a Phase II site investigation will also be conducted. • Prepare a site plan that identifies any necessary remediation activities appropriate for proposed land uses, including excavation and removal of contaminated soils and redistribution of clean fill material on the project site. The plan would include measures that ensure the safe transport, use and disposal of contaminated soil and building debris removed from the site, as well as any other hazardous materials. In the event that contaminated groundwater is encountered during site excavation activities, the contractor would report the contamination to the appropriate regulatory agencies, dewater the excavated area and treat the contaminated groundwater to remove contaminants before discharge into the sanitary sewer system. The contractor would be required to comply with the plan and applicable Federal, State and local laws.	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		• Notify appropriate Federal, State and local agencies if evidence of previously undiscovered soil or groundwater contamination is encountered during construction. Any contaminated areas would be cleaned up in accordance with the recommendations of the Central Valley Regional Water Quality Control Board (Regional Board), California DTSC or other appropriate Federal, State or local regulatory agencies. • A worker health and safety plan would be prepared before the start of construction that identifies, at a minimum, all contaminants that could be encountered during construction; all appropriate worker, public health and environmental protection equipment and procedures to be used during project activities; emergency response procedures; the most direct route to the nearest hospitals; and a Site Safety Officer. The plan would describe actions to be taken if hazardous materials are encountered on-site, including protocols for handling hazardous materials, preventing their spread and emergency procedures to be taken in the event of a spill. • Retain licensed contractors to remove all underground storage tanks.	
3.3.2 Recreation			
Development of CMP-covered mitigation sites could increase the use of existing neighborhood and regional parks or other recreational facilities, such that substantial physical deterioration of the facility would occur or be accelerated, or result in substantial adverse physical impacts associated with the need for new or physically altered parks or recreational facilities.	PS	**Mitigation Measure 3.6-16** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-17** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-18** (See text under Impact VW-1, VW-2, VW-3, and VW-4) **Mitigation Measure 3.6-19** (See text under Impact VW-1, VW-2, VW-3, and VW-4)	Consistent with previous EIRs (SU)
3.3.2 Transportation			
Construction of CMP-covered mitigation sites could conflict with a program, plan, ordinance, or policy addressing the circulation system, including transit, roadway, bicycle, and pedestrian facilities, or result in inadequate emergency access.	PS	**Mitigation Measure 3.11-1: Traffic Safety Plan.** Before the start of each construction season, the primary contractors for construction shall hire a licensed traffic engineer to develop a coordinated construction traffic safety and control plan in accordance with the latest Manual on Uniform Traffic Control Devices (MUTCD) standards and requirements to minimize the simultaneous use of roadways by different construction contractors for material hauling and equipment delivery to the extent feasible and to avoid and minimize potential traffic hazards on local roadways during construction.	Consistent with previous EIRs (SU)

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		Items (a) through (i) of this mitigation measure shall be integrated as terms of the construction contracts. (a) The plan shall outline phasing of activities and the use of multiple routes to and from off-site locations to minimize the daily amount of traffic on individual roadways. (b) The plan shall provide bicycle and pedestrian detours to allow for continued use by bicycle and pedestrian commuters and maintain safe pedestrian and bicyclist access around the construction areas at all times. Construction areas shall be secured as required by the applicable jurisdiction to prevent pedestrians and bicyclists from entering the work site, and all stationary equipment shall be located as far away as possible from areas where bicyclists and pedestrians are present. (c) The construction contractors shall develop traffic control plans (TCP) for the local roadways that would be affected by construction traffic. The TCP must be designed and stamped by a licensed traffic engineer in accordance with the latest MUTCD requirements. The TCP must be submitted by the contractor with the City’s road encroachment permit application for review and approval. Before the initiation of construction-related activity involving high volumes of traffic, the plan shall be submitted for review by the agency of local jurisdiction (San Joaquin County, City of Stockton, or Caltrans [if applicable]) that has responsibility for roadway safety at and between CMP-covered mitigation sites. The contractor shall train construction personnel in appropriate safety measures as described in the plan and shall implement the plan. The plan shall include the prescribed locations for staging equipment and parking trucks and vehicles. Provisions shall be made for overnight parking of haul trucks to avoid causing traffic or circulation congestion. The plan shall call for the following elements: o Posting warnings about the potential presence of slow-moving vehicles. o Using traffic control personnel when appropriate. o Placing and maintaining barriers and installing traffic control devices necessary for safety, as specified in Caltrans’ Manual of Traffic Controls for Construction and Maintenance Work Zones and in accordance with city/county requirements. o The TCP shall include signs placed on March Lane west of I-5 advising the public of traffic delays due to construction and the tentative timeline of the project. Language to be placed on the signs must be approved by the City’s traffic engineer. (d) All operations shall limit and expeditiously remove, as necessary, the accumulation of mud or dirt generated from CMP-covered mitigation site activities from adjacent	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		public streets at least once every 24 hours if substantial volumes of soil are carried onto adjacent paved public roadways during construction. (e) If needed to comply with Caltrans requirements, a transportation management plan shall be prepared and submitted to Caltrans to cover any points of access from the state highway system for haul trucks and other construction equipment. (f) Before the start of the first construction season, the construction contractor shall obtain a road encroachment permit with San Joaquin County and the City of Stockton to address permit conditions set for the maintenance and repair of affected roadways resulting from increased truck traffic. The road encroachment permit conditions and requirements shall ensure that the affected roadways are repaired to a level that is equivalent to their pre-project condition. Such an agreement may require the contractor to take pre-project photos of existing conditions. Upon project completion, the City or County shall develop a punch list of requirements to ensure that pre-project conditions are restored. (g) Before construction of CMP-covered mitigation sites begins, the contractor shall provide notification of construction to all appropriate emergency service providers in San Joaquin County, Stockton, Lathrop, and Manteca and shall coordinate with providers throughout the construction period to ensure that emergency access through construction areas is maintained. (h) The contractor shall avoid neighborhoods and school zones to the maximum extent feasible when determining haul routes. When possible, hauling in school zones shall be limited to the period of summer breaks to avoid noise and traffic impacts on the schools. Any damage to residential roadways during construction shall be mitigated per the requirements outlined in the traffic safety and control plan. (i) During preliminary engineering and design, the Project proponent shall provide notification of CMP-covered mitigation site construction to all appropriate railroads in the CMP-covered mitigation site area and shall coordinate with all railroads to minimize freight and passenger service disruptions. Prior to the start of construction, the Project proponent's contractor shall contact the general manager of affected railroads to coordinate truck haul route traffic and schedule an on-site meeting.	
Construction of CMP-covered mitigation sites could conflict or be inconsistent with CEQA Guidelines Section 15064.3, Subdivision (b).	LTS	**None required.**	NA

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
3.3.2 Utilities, Service Systems, Public Services			
Development of CMP-covered mitigation sites could result in substantial adverse physical impacts associated with the need for new or physically altered public service facilities; substantially increase need for new or physically altered public services facilities; require new or expanded entitlements to provide sufficient water supplies; require or result in the construction of new stormwater drainage or wastewater treatment facilities or expansion of existing facilities; or be served by a landfill with insufficient permitted capacity to accommodate the project's solid waste disposal needs.	PS	**Mitigation Measure 3.2.8-1: Coordination with Utility Providers & Response Plan.** The mitigation measures for Alternative 7a outlined in Section 5.16.10 of the 2018 LSJR FR/EIS/EIR shall be applied to development of CMP-covered mitigation sites: Before beginning construction, coordination with utility providers to implement orderly relocation of utilities that need to be removed or relocated would occur. Coordination would include the following: • Notification of any potential interruptions in service shall be provided to the appropriate agencies and affected landowners. • Before the start of construction, utility locations shall be verified through field surveys and the use of Underground Service Alert services. Any buried utility lines shall be clearly marked where construction activities would take place and on the construction specifications before of any earthmoving activities begin. • Before the start of construction, the contractor would be required to coordinate with the local municipality and acquire any applicable permits prior to use of municipal water for construction. • Before the start of construction, a response plan shall be prepared to address potential accidental damage to a utility line. The plan shall identify chain of command rules for notification of authorities and appropriate actions and responsibilities to ensure the public and worker safety. Worker education training in response to such situations shall be conducted by the contractor. The response plan shall be implemented by the contractor during construction activities. • Utility relocations shall be staged to minimize interruptions in service.	LTS
3.3.2 Wildfire			
Development of CMP-covered mitigation sites could substantially impair an adopted emergency response plan or emergency evacuation plan or require the installation or maintenance of associated infrastructure (such as roads, fuel breaks, emergency water sources, power lines, or	LTS	**None required.**	NA

Table 2
Summary of CEQA Impacts and Mitigation Measures

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
other utilities) that may exacerbate fire risk or that may result in temporary or ongoing impacts to the environment or expose people or structures to significant risks, including downslope or downstream flooding or landslides, as a result of runoff, post-fire slope instability, or drainage changes.			
Development of CMP-covered mitigation sites could, due to slope, prevailing winds, and other factors, exacerbate wildfire risks, and thereby expose project occupants to pollutant concentrations from a wildfire or the uncontrolled spread of a wildfire.	PS	**Mitigation Measure 3.13-1: Worker Health and Safety Plan.** A worker health and safety plan shall be prepared before the start of construction that identifies, at a minimum, all contaminants that could be encountered during construction; all appropriate worker, public health, and environmental protection equipment and procedures to be used during project activities; emergency response procedures; the most direct route to the nearest hospitals; and a Site Safety Officer. The plan shall describe actions to be taken if hazardous materials are encountered on-site, including protocols for handling hazardous materials, preventing their spread and emergency procedures to be taken in the event of a spill.	LTS
3.6 Water Quality			
Impact WQ-1 and WQ-2: Development of CMP-covered mitigation sites could violate a water quality standard or waste discharge requirement or otherwise substantially degrade water quality, or create or contribute runoff water that would provide substantial additional sources of non-point-source related runoff or conflict with or obstruct implementation of a water quality control plan.	PS	**Mitigation Measure 3.2.6-1: Water Quality Avoidance and Minimization Measures.** The mitigation measures for Alternative 7a outlined in Section 5.5.10 of the 2018 LSJR FR/EIS/EIR shall be applied to development of CMP-covered mitigation sites in addition to all requirements of the SWPPP, BSSCP, and SPCCP: • The contractor will obtain a Construction Stormwater General Permit (CGP) containing a spill prevention control and countermeasure plan (SPCCP) and a SWPPP prior to initiation of construction in accordance with guidance from the Regional Board, Central Valley Region. These plans would be reviewed and approved by USACE before construction begins. • Implement appropriate measures to prevent debris, soil, rock, or other material from entering the water. Use vacuum sweepers or other appropriate measures to control dust on haul roads, construction areas and stockpiles. • Implement appropriate measures for containing, handling and disposing of concrete and concrete washout water.	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		• Properly dispose of oil or other liquids. • Fuel and maintain vehicles in a specified area that is designed to capture spills. This area cannot be near any ditch, stream or other body of water or feature that may convey water. • Fuels and hazardous materials storage on the waterside of levees is prohibited and hazardous materials in general should not be stored on site without proper, two-factor containment. • Inspect and maintain vehicles and equipment to prevent dripping oil and other fluids. • Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, erosion control measures would be implemented as described in the Regional Board Erosion and Sediment Control Field Manual and as required as part of the CGP. • Maintain sediment and erosion control measures during construction. Inspect the control measures before, during and after a rain event. • Train construction workers in SWPPP and how to respond to, control, contain and clean up spills. • Revegetate disturbed areas in a timely manner to control erosion. • Materials will be covered and protected from wind, rain and runoff to avoid unwarranted dispersal. • Refine operational criteria to ensure that desired Flood Risk Management (FRM) benefits are achieved while avoiding degradation of water quality behind the closure structures.	
3.7 Groundwater			
Impact GW-1 and GW-2: Development of CMP-covered mitigation sites could substantially deplete groundwater supplies or interfere substantially with groundwater recharge such that there would be a net deficit in aquifer volume or a lowering of the local groundwater table level or substantially affect the quality of the groundwater supply or obstruct implementation of a groundwater management plan.	LTS	**None required.**	NA

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
3.8 Wetlands and other Waters of the United States			
Impact WW-1: Development of CMP-covered mitigation sites would have a substantial adverse effect on state or federally protected wetlands (including but not limited to marsh, vernal pool, and coastal) through direct removal, filling, hydrological interruption, or other means.	PS	**Mitigation Measure 3.6-20: No Net Loss of Wetlands/Waters.** SJAFCA shall conduct an aquatic resources delineation to identify potential wetlands and other waters that fall under state and federal jurisdiction within mitigation sites and borrow sites. Temporary and permanent impacts on riparian habitat and wetland/waters that cannot be mitigated through avoidance, minimization, or remediation shall be mitigated to ensure no net loss through compensation, by restoring riparian and wetlands/waters habitat at one of the proposed biological mitigation sites or an approved off-site location, mitigation bank, or in-lieu fee program. Riparian and wetlands/waters habitat shall not be restored where it would be removed by future maintenance activities. A revegetation plan shall be prepared by a qualified biologist or landscape architect and reviewed by the appropriate agencies. The revegetation plan will specify the use of beneficial native plants appropriate for each area that provide a diverse variety of grasses and forbs that support native wildlife species.	LTS
3.11 Vegetation and Wildlife			
Impact VW-1, VW-2, VW-3, and VW-4: Development of CMP-covered mitigation sites would have a substantial adverse effect on any riparian habitat or other sensitive natural community identified in local or regional plans, policies, regulations, or by CDFW or USFWS or interfere substantially with the movement of any native resident or migratory fish or wildlife species or with established native resident or migratory wildlife corridors, or impede the use of native wildlife nursery sites, or conflict with any local policies or ordinance protection biological resources, such as a tree preservation policy or ordinance, or conflict with the provisions of an adopted habitat conservation plan, natural community conservation plan, or other approved local, regional, or state habitat conservation plan.	PS	**Mitigation Measure 3.6-16 Temporary Fencing.** To clearly demarcate the CMP-covered mitigation sites' boundaries and protect sensitive natural communities, temporary exclusion fencing shall be installed around the CMP-covered mitigation sites' boundaries (e.g., access roads, staging areas) 1 week prior to the start of construction activities. The temporary fencing shall be continuously maintained until all construction activities are completed so that construction equipment is confined to the designated work areas, including any off-site mitigation areas and access thereto. The exclusion fencing shall be removed only after construction for the year is entirely completed. Exclusionary construction fencing and explanatory signage shall be placed around the perimeter of sensitive vegetation communities that could be affected by construction activities throughout the period during which such effects occur. The signage will explain the nature of the sensitive resource and warn that no effect on the community is allowed. Where feasible, the fencing will include a buffer zone of at least 20 feet between the resource and construction activities. All exclusionary fencing shall be maintained in good condition throughout the construction period. **Mitigation Measure 3.6-17 Mandatory Contractor/Worker Awareness Training**. Before the initiation of any work in the Area of CMP-covered mitigation sites, including grading, a qualified biologist shall conduct mandatory contractor/worker awareness	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		training for all construction personnel. This training shall be provided to brief workers on the need to avoid effects on sensitive biological resources (e.g., riparian habitat, special-status species, wetlands, and other sensitive biological communities) and the penalties for not complying with permit requirements. The biologist shall inform all construction personnel about the life history of special-status species with potential for occurrence on the site, the importance of maintaining habitat, and the terms and conditions of the BO or other authorizing document. Proof of this instruction shall be submitted to USFWS. The training shall also cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on sensitive biological communities and special-status species during Construction of CMP-covered mitigation sites. The crew leader shall be responsible for ensuring that crew members adhere to the guidelines and restrictions. Educational training shall be conducted for new personnel as they are brought on the job. General restrictions and guidelines for vegetation and wildlife that must be followed by construction personnel are listed below. • Vehicles shall observe the posted speed limit on hard-surfaced roads and a speed limit of 10 miles per hour on unpaved roads during travel on the project site. • Vehicles and construction equipment shall restrict their off-road travel to the designated construction area. • To prevent possible resource damage from hazardous materials such as motor oil or gasoline, construction personnel shall not service vehicles or construction equipment outside designated staging areas. **Mitigation Measure 3.6-18 Construction Monitoring.** A qualified biologist shall monitor construction activities adjacent to sensitive biological resources (e.g., special-status species, riparian habitat, wetlands, elderberry shrubs), as needed. The biologist shall assist the construction crew, as needed, to comply with all CMP-covered mitigation site implementation restrictions and guidelines. In addition, the biologist shall be responsible for ensuring that construction barrier fencing is maintained adjacent to sensitive biological resources. **Mitigation Measure 3.6-19: Riparian Compensation.** Vegetation impacts that cannot be mitigated through avoidance, minimization, or remediation shall be mitigated through restoration at the selected biological mitigation site. A revegetation plan for the	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		biological mitigation site shall be prepared by a qualified biologist or landscape architect and reviewed by the appropriate agencies. The revegetation plan shall specify the planting stock appropriate for each riparian cover type and each mitigation site, ensuring the use of genetic stock from the Area of CMP-covered mitigation sites, and shall employ the most successful techniques available at the time of planting. The plantings shall be maintained and monitored as necessary for 3–5 years, including weed removal, irrigation, and herbivory protection. For this establishment period, USACE shall submit annual monitoring reports of survival to the regulatory agencies including USFWS, NMFS, and CDFW. Replanting will be necessary if success criteria are not met, with replacement plants subsequently monitored and maintained to meet the success criteria. The mitigation will be considered successful when the plants meet the success criteria and the vegetation no longer requires active management and is arranged in groups that, when mature, replicate the area, natural structure, and species composition of similar plant communities in the region. If mitigation at the selected biological mitigation site is inadequate to fully compensate for the vegetation impacts, the remaining balance of compensation required for riparian, shaded riverine aquatic, wetland, and open water habitats shall be accomplished through the purchase of credits at a mitigation bank or the construction of additional mitigation sites. If an alternative biological mitigation site not evaluated in this SEIR is chosen for development, additional environmental review under CEQA will be required prior to construction.	
3.13 Special Status Species			
Impact SS-1: Development of CMP-covered mitigation sites would have a substantial adverse effect, either directly or through habitat modifications, on any species identified as a candidate, sensitive, or special-status species in local or regional plans, policies, or regulations, or by CDFW or USFWS.	PS	**Mitigation Measure 3.6-1: Special-Status Plant Surveys.** Before Construction of CMP-covered mitigation sites, surveys for special-status plants with potential to occur shall be conducted by a qualified botanist at the appropriate time of year when the target species would be in flower or otherwise clearly identifiable. Surveys shall be conducted in accordance with specific guidelines described by *Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities* (CDFW 2018). **Mitigation Measure 3.6-2: Special-Status Plant Measures.** If special-status plants are found, the following measures shall be implemented:	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		• Qualified botanists shall survey the biological study area to document the presence of special-status plants before CMP-covered mitigation site implementation and shall conduct a floristic survey that follows the CDFW botanical survey guidelines (CDFW 2018). All plant species observed will be identified to the level necessary to determine whether they qualify as special-status plants or are plant species with unusual or significant range extensions. The guidelines also require that field surveys be conducted when special-status plants that could occur in the area are evident and identifiable, generally during the reported blooming period. To account for different special-status plant identification periods, one or more series of field surveys may be required in spring and summer. If any special-status plants are identified during the surveys, the botanist shall photograph and map locations of the plants, document the location and extent of the special-status plant population on a CNDDB survey form, and submit the completed survey form to the CNDDB. The amount of compensatory mitigation required will be based on the results of these surveys. • If one or more special-status plants is identified in the biological study area during preconstruction surveys, the sponsor shall redesign or modify the CMP-covered mitigation site, including the restoration plans for the biological mitigation site components, to avoid indirect or direct effects on special-status plants wherever feasible. If special-status plants cannot be avoided by redesigning projects, compensatory mitigation shall be implemented to avoid significant effects on special-status plants. • If complete avoidance of special-status plants is not feasible, the effects of the CMP-covered mitigation site on special-status plants shall be mitigated through off-site preservation at the chosen biological mitigation site at a minimum of a 1:1 ratio but shall be negotiated with the resource agencies. Suitable habitat for affected special-status plant species will occur in a conservation area, preserved and managed in perpetuity. Detailed information shall be provided to the agencies on the location and quality of the preservation area, the feasibility of protecting and managing the area in perpetuity, and the responsible parties. Other pertinent information also shall be provided, to be determined through future coordination with the resource agencies.	

Table 2
Summary of CEQA Impacts and Mitigation Measures

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		Mitigation Measure 3.6-3: Worker Awareness Training. Before ground disturbance, all construction personnel shall participate in a CDFW-approved worker environmental awareness program. A qualified biologist shall inform all construction personnel about the life history of Swainson's hawk and the importance of nest sites and foraging habitat. **Mitigation Measure 3.6-4: Breeding-Season Survey.** If construction work is to occur during the Swainson's hawk breeding season, a breeding-season survey for nesting birds shall be conducted for all trees and shrubs that would be removed or disturbed that are located within 500 feet (0.5 mile for Swainson's hawk) of construction activities, including grading. Swainson's hawk surveys shall be completed during at least two of the following survey periods: January 1 to March 20; March 20 to April 5; April 5 to April 20; and June 10 to July 30. No fewer than three surveys shall be completed in at least two survey periods and at least one of these surveys shall occur immediately prior to CMP-covered mitigation site initiation (SWHA TAC 2000). Other migratory bird nest surveys could be conducted concurrent with Swainson's hawk surveys, with at least one survey to be conducted no more than 48 hours from the initiation of CMP-covered mitigation site activities to confirm the absence of nesting. If the biologist determines that the area surveyed does not contain any active nests, construction activities, including removal or pruning of trees and shrubs, could commence without any further mitigation. **Mitigation Measure 3.6-5: Active Nest Buffer.** If active nests are found, USACE shall maintain a 0.25-mile buffer between construction activities and the active nest(s). In addition, a qualified biologist shall be present on-site during construction activities to ensure that the buffer distance is adequate and that the birds are not showing any signs of stress. If signs of stress that could cause nest abandonment are noted, construction activities shall cease until a qualified biologist determines that fledglings have left an active nest. With the written permission of the wildlife agencies and under the supervision of the qualified biologist, work within the temporary nest disturbance buffer may occur. The qualified biologist shall be on-site daily while construction-related activities are taking place within the buffer. **Mitigation Measure 3.6-6: Burrowing Owl Preconstruction Surveys.** Prior to initiation of any excavation activities at borrow sites, a preconstruction survey for burrowing owls shall be completed in accordance with CDFW guidelines described in the *Staff Report on Burrowing Owl Mitigation*. If no burrowing owls are located during	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		these surveys, then effects on burrowing owls would be less than significant and no mitigation is required. If burrowing owls are located on or immediately adjacent to the site, then coordination shall occur with CDFW to determine the measures that need to be implemented to ensure that burrowing owls are not affected by the CMP-covered mitigation site. Potential mitigation measures that could be implemented include: • A qualified biologist shall conduct appropriate surveys at and around material source sites, to determine the presence/absence of burrowing owls. At least one survey shall be conducted no more than 1 week prior to the onset of any construction activity. • A 250-foot buffer, within which no new activity would be permissible, shall be maintained between CMP-covered mitigation site activities and nesting burrowing owls. This protected area shall remain in effect until August 31 or at CDFW's discretion, until the young owls are foraging independently. • No burrowing owls shall be evicted from burrows during the nesting season (February 1 through August 31). Eviction outside the nesting season could be permitted pending evaluation of eviction plans and receipt of formal written approval from CDFW authorizing the eviction. • Mandatory worker awareness training for construction personnel shall be conducted. **Mitigation Measure 3.6-7: Nesting Bird Surveys.** USACE shall conduct surveys in the spring of each construction year to locate nest sites of the mentioned species in suitable breeding habitats. Surveys shall be conducted by a qualified biologist using survey methods approved by USFWS. Survey results shall be submitted to USFWS before construction is initiated. If nests or young of these species are not located, construction may proceed. If nests or young are located, USACE shall coordinate with USFWS and CDFW to determine what mitigation measures could be implemented to avoid or reduce potential disturbance-related impacts on these species. Measures could include a no-disturbance buffer zone established around the nest site. The width of the buffer zone shall be determined by a qualified biologist in coordination with USFWS. No construction activities shall occur within the buffer zone, which shall be maintained until the young have fledged (as determined by a qualified biologist). **Mitigation Measure 3.6-8: Minimization of Effects on Giant Garter Snake.** The following measures shall be implemented to minimize effects on giant garter snake	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997). • Unless approved otherwise by USFWS, construction shall be initiated only during the giant garter snake active period (May 1–October 1, when they are able to move away from disturbance). • All construction personnel, including workers and contractors, shall participate in a worker environmental awareness training program conducted by a USFWS-approved biologist prior to commencement of construction activities. • A giant garter snake survey shall be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than 2 weeks, a biologist shall survey the Area of CMP-covered mitigation sites again no later than 24 hours prior to the restart of work. • Giant garter snakes encountered during construction activities shall be allowed to move away from construction activities on their own. • Movement of heavy equipment to and from the construction site shall be restricted to established roadways. • Giant garter snake habitat within 200 feet of construction activities shall be designated as an environmentally sensitive area and delineated with signs and high-visibility fencing. Fencing shall be inspected and maintained as needed daily until completion of each work section of the CMP-covered mitigation site. This area shall be avoided by all construction personnel. • If USACE elects to use exclusionary fencing in lieu of continuous monitoring, it shall be buried at least 6 inches below the ground to prevent snakes from burrowing and moving under the fence and shall be inspected daily. • If a frac-out is identified, all work shall stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out shall be determined and the frac-out shall be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location). • USFWS, NMFS, CDFW, and the Regional Water Quality Control Board shall be notified immediately of any spills and will be consulted regarding clean-up	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		procedures. A Brady barrel will be on-site and shall be used if a frac-out occurs. Containment materials, such as straw bales, also will be on-site prior to and during all operations and a vacuum truck will be on retainer and available to be operational on-site within 2 hours' notice. The site supervisor shall take any necessary follow-up response actions in coordination with agency representatives. The site supervisor shall coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks) as needed. • If the frac-out has reached the surface, any material contaminated with bentonite shall be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor shall be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner. • Project-related vehicles shall observe a 10 mph speed limit within construction areas, except on existing paved roads where they shall adhere to the posted speed limits. • Aquatic habitat for the snake that would be affected by construction shall be inspected for the snake, then dewatered and maintained dry and absent of aquatic prey for 5 days before initiation of construction activities. This measure applies primarily to the ditches to be relocated west of the Delta front levee sections. If complete dewatering is not possible, USFWS shall be contacted to determine what additional measures, if any, may be necessary to minimize effects on the snake. **Mitigation Measure 3.6-9: Giant Garter Snake Compensation.** If giant garter snake habitat would be temporarily affected during construction, the following measures shall be implemented to compensate for the habitat loss at the selected biological mitigation site: • Habitat (including aquatic and upland) temporarily affected for one construction season (May 1–October 1) shall be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		• Aquatic habitat permanently affected shall be replaced at a 3:1 ratio through the purchase of credits at a mitigation bank or the establishment of aquatic habitat at one of the mitigation sites. • Upland habitat permanently affected shall be replaced at a minimum of 1:1 ratio. • USACE shall work to develop appropriate mitigation prior to or concurrent with any disturbance of giant garter snake habitat. Habitat shall be protected in perpetuity and have an endowment attached for management and maintenance. **Mitigation Measure 3.6-10: Minimization of Any Potential Effects on VELB or Their Habitat.** During construction for the CMP-covered mitigation site, USACE shall implement the measures included in the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle* (USFWS 2017b; see Appendix G) to reduce effects on valley elderberry longhorn beetle. The framework includes avoidance and minimization measures for shrubs that would not be transplanted within 50 meters of the Project, methodologies for transplanting of shrubs, and methodologies for compensatory mitigation guidance for removed habitat. **Mitigation Measure 3.6-11: VELB Compensation**. In accordance with the USFWS 2017 *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (Desmocerus californicus dimorphus),* adverse effects on the VELB shall be compensated for by transplanting the affected elderberries with stems greater than 1 inch in diameter and by planting a mix of native suitable riparian vegetation at a 3:1 ratio. The amount of compensation for VELB shall be based on USFWS review. A suitable transplant site shall be selected and planted with transplanted shrubs and new seedlings and associated riparian habitat, in accordance with the USFWS guidelines. **Mitigation Measure 3.6-12: Bat and Roosting Habitat Survey.** In advance of tree removal, a preconstruction survey for special-status bats shall be conducted by a qualified biologist to characterize potential bat habitat and identify active roost sites within the CMP-covered mitigation site. Should potential roosting habitat or active bat roosts be found in trees and/or structures to be removed under the CMP-covered mitigation site, the following measures shall be implemented: • Removal of trees and structures shall occur when bats are active, approximately March 1–April 15 and August 15–October 15, and outside of bat maternity roosting	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation

		season (approximately April 15–August 31) and months of winter torpor (approximately October 15–February 28), to the extent feasible.
		• If removal of trees during the periods when bats are active is not feasible and active bat roosts being used for maternity or hibernation purposes are found on or in the immediate vicinity of the CMP-covered mitigation site where tree removal is planned, a no-disturbance buffer of 100 feet shall be established around these roost sites until they are determined to be no longer active by the qualified biologist.
		• The qualified biologist shall be present during tree removal if active bat roosts that are not being used for maternity or hibernation purposes are present. Trees with active roosts shall be removed only when no rain is occurring or is forecast to occur for 3 days and when daytime temperatures are at least 50 degrees Fahrenheit.
		• Removal of trees with active or potentially active roost sites shall follow a two-step removal process:
		  o On the first day of tree removal and under supervision of the qualified biologist, branches and limbs not containing cavities or fissures in which bats could roost, shall be cut only using chain saws.
		  o On the following day and under the supervision of the qualified biologist, the remainder of the tree may be removed, using either chain saws or other equipment (e.g., excavator or backhoe).
		• Removal of structures containing or suspected to contain active bat roosts, that are not being used for maternity or hibernation purposes, shall be dismantled under the supervision of the qualified biologist in the evening and after bats have emerged from the roost to forage. Structures shall be partially dismantled to significantly change the roost conditions, causing bats to abandon and not return to the roost. If deemed necessary by a qualified biologist, bat exclusion devises may be installed to prevent the re-entry of bats to a roost.
		
		Mitigation Measure 3.6-13: Hazardous Materials Spill Notification. Given the deleterious effects of numerous chemicals on native resident fish used in construction, if a hazardous materials spill does occur, a detailed analysis shall be performed immediately by a registered environmental assessor or professional engineer to identify the likely cause and extent of contamination. This analysis shall conform to American Society for Testing and Materials standards and shall include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, USACE and its contractors shall select and implement measures to control	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		contamination, with a performance standard that surface water and groundwater quality must be returned to baseline conditions. **Mitigation Measure 3.6-14: In-Water Work Windows.** In-water construction for the biological mitigation sites shall be restricted to the general estimated work window required for each waterway as described in the NMFS 2016 BO or superseding BO. During preconstruction engineering and design, the work window may be adjusted on a site-specific basis, considering periods of low fish abundance, and in-water construction outside the principal spawning and migration season. The typical construction season generally corresponds to the dry season, but construction may occur outside the limits of the dry season, only as allowed by applicable permit conditions. **Mitigation Measure 3.6-15: Avoidance and Minimization of Effects on Listed Fish Species.** In 2016, NMFS issued a BO for the LSJR Feasibility Study consultation for levee improvements. The NMFS BO evaluated impacts on Central Valley spring-run Chinook salmon, California Central Valley steelhead, and green sturgeon, as well as their critical habitat. The BO evaluated potential impacts based on rough estimates and preliminary designs for the proposed Project. To avoid and minimize effects on listed fish species, the measures from the 2016 NMFS BO or superseding BO shall be implemented.	
3.15 Land Use			
Impact LU-1 and LU-2: Development of CMP-covered mitigation sites would not physically divide an established community or cause a significant environmental impact due to a conflict with any land use plan, policy, or regulation adopted for the purpose of avoiding or mitigating an environmental effect.	NI	**None required.**	NA
3.19 Cultural Resources			
Impact CULT-1: Development of CMP-covered mitigation sites may cause a substantial adverse change in the significance of a historical resource	NI (project-level components);	**None currently available.**	Consistent with previous EIRs: NI

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
pursuant to State CEQA Guidelines Section 15064.5.	PS (program-level components)		(project-level components); SU (program-level components)
Impact CULT-2: Development of CMP-covered mitigation sites could cause a substantial adverse change in the significance of an archaeological resource pursuant to State CEQA Guidelines Section 15064.5.	PS	**Mitigation Measure 3.7-1: Cultural Resources Awareness Training.** USACE in consultation with SJAFCA and other interested parties shall provide a cultural resources and tribal cultural resources sensitivity and awareness training program for all personnel involved in Construction of CMP-covered mitigation sites, including field consultants and construction workers. The training shall be developed in coordination with an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for Archeology, as well as culturally and geographically affiliated Native American tribes. SJAFCA may invite Native American representatives from interested culturally and geographically affiliated Native American Tribes to participate. The training shall be conducted before any CMP-covered mitigation site–related construction activities begin and shall include relevant information regarding sensitive cultural resources and tribal cultural resources, including applicable regulations, protocols for avoidance, and consequences of violating federal and state laws and regulations. The training shall also describe appropriate avoidance and impact minimization measures for cultural resources and tribal cultural resources that could be located on the CMP-covered mitigation site and shall outline what to do and whom to contact if any potential cultural resources or tribal cultural resources are encountered. The training shall emphasize the requirement for confidentiality and culturally appropriate treatment of any discovery of significance to Native American Tribes and shall discuss appropriate behaviors and responsive actions, consistent with Native American tribal values.	Consistent with previous EIRs: LTS (project-level components); SU (program-level components)
3.19 Cultural Resources (cont.)			
Impact CULT-2 (cont.)		**Mitigation Measure 3.7-2: Inadvertent Discovery of Cultural Materials.** If an inadvertent discovery of cultural materials (e.g., unusual amounts of shell, animal bone, any human remains, bottle glass, ceramics, building remains), tribal cultural resources, sacred sites, or landscapes is made at any time during Project-related construction activities, USACE in consultation with SJAFCA and other interested parties, and in coordination with an archaeologist meeting the Secretary of the Interior's Professional	

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		Qualifications Standards for Archeology and culturally and geographically affiliated Native American tribes, shall develop appropriate protection and avoidance measures where feasible. These procedures shall be developed in accordance with the Lower San Joaquin River Feasibility Study Project PA and associated HPMP, which specifies procedures for post-review discoveries. Additional measures, such as development of a Historic Properties Treatment Plan prepared in accordance with the PA and HPMP, may be necessary if avoidance or protection is not possible.	
Impact CULT-3: Development of CMP-covered mitigation sites could disturb human remains, including those interred outside of dedicated cemeteries.	PS	**Mitigation Measure 3.7-3: Inadvertent Discovery of Human Remains.** In accordance with the California Health and Safety Code, if human remains are uncovered during ground-disturbing activities, USACE shall immediately halt potentially damaging excavation in the area of the burial and notify the County coroner and an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for Archeology to determine the nature of the remains. The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (HSC Section 7050.5[b]). If the coroner determines that the remains are those of a Native American, they must contact the NAHC by phone within 24 hours of making that determination (HSC Section 7050[c]). After the coroner's findings have been made, the archaeologist and the NAHC-designated Most Likely Descendant (MLD), in consultation with USACE and SJAFCA, shall determine the ultimate treatment and disposition of the remains. Upon the discovery of Native American human remains, USACE in coordination with SJAFCA, shall require that all construction work stop within 100 feet of the discovery until consultation with the MLD has taken place. The MLD shall have 48 hours to complete a site inspection and make recommendations to the USACE and SJAFCA after being granted access to the site. A range of possible treatments for the remains, including nondestructive removal and analysis, preservation in place, relinquishment of the remains and associated items to the descendants, or other culturally appropriate treatment may be discussed. PRC Section 5097.98(b)(2) suggests that the concerned parties may mutually agree to extend discussions beyond the initial 48 hours to allow for the discovery of additional remains. If agreed to by the MLD, SJAFCA or SJAFCA's authorized representative shall rebury the Native American human remains and associated grave goods with appropriate dignity on the property in a location not subject	LTS

TABLE 2
SUMMARY OF CEQA IMPACTS AND MITIGATION MEASURES

Impact	Significance Before Mitigation	Mitigation Measure	Significance After Mitigation
		to further subsurface disturbance. Construction work in the vicinity of the burials shall not resume until the mitigation is completed.	
Impact TCR-1: Development of CMP-covered mitigation sites could cause a substantial adverse change in the significance of a tribal cultural resource as defined in PRC Section 21074.	PS	**Mitigation Measure 3.7-1: Cultural Resources Awareness Training** (See text under Impact CULT-2 and CULT-3) **Mitigation Measure 3.7-2: Inadvertent Discovery of Cultural Materials** (See text under Impact CULT-2 and CULT-3) **Mitigation Measure 3.7-3: Inadvertent Discovery of Human Remains** (See text under Impact CULT-2 and CULT-3)	Consistent with previous EIRs (SU)

APPENDIX C
Public Comments and Responses

This Draft SEA/SEIR will be circulated for public review from May 20 to July 7, 2025. A public meeting will be held on June 2, 2025 from 6:00 pm to 7:00 pm at the Stribley Center, 1760 East Sonora Street, Stockton, CA 95205. Substantive comments received during the public review period along with responses from USACE and/or the NFS will be incorporated into the final SEA/SEIR as appropriate and will be summarized and included in this Appendix to the final report.

APPENDIX D

USFWS IPAC and CDFW CNDDB Species Lists

This Draft SEA/SEIR will be circulated for public review from May 20 to July 7, 2025. A public meeting will be held on June 2, 2025 from 6:00 pm to 7:00 pm at the Stribley Center, 1760 East Sonora Street, Stockton, CA 95205. Substantive comments received during the public review period along with responses from USACE and/or the NFS will be incorporated into the final SEA/SEIR as appropriate and will be summarized and included in this Appendix to the final report.

IPaC resource list

This report is an automatically generated list of species and other resources such as critical habitat (collectively referred to as *trust resources*) under the U.S. Fish and Wildlife Service's (USFWS) jurisdiction that are known or expected to be on or near the project area referenced below. The list may also include trust resources that occur outside of the project area, but that could potentially be directly or indirectly affected by activities in the project area. However, determining the likelihood and extent of effects a project may have on trust resources typically requires gathering additional site-specific (e.g., vegetation/species surveys) and project-specific (e.g., magnitude and timing of proposed activities) information.

Below is a summary of the project information you provided and contact information for the USFWS office(s) with jurisdiction in the defined project area. Please read the introduction to each section that follows (Endangered Species, Migratory Birds, USFWS Facilities, and NWI Wetlands) for additional information applicable to the trust resources addressed in that section.

Location

California

Local offices

San Francisco Bay-Delta Fish And Wildlife

(916) 930-5603
(916) 930-5654

650 Capitol Mall
Suite 8-300

Sacramento, CA 95814

Sacramento Fish And Wildlife Office

(916) 414-6600
(916) 414-6713

Federal Building
2800 Cottage Way, Room W-2605
Sacramento, CA 95825-1846

Endangered species

This resource list is for informational purposes only and does not constitute an analysis of project level impacts.

The primary information used to generate this list is the known or expected range of each species. Additional areas of influence (AOI) for species are also considered. An AOI includes areas outside of the species range if the species could be indirectly affected by activities in that area (e.g., placing a dam upstream of a fish population even if that fish does not occur at the dam site, may indirectly impact the species by reducing or eliminating water flow downstream). Because species can move, and site conditions can change, the species on this list are not guaranteed to be found on or near the project area. To fully determine any potential effects to species, additional site-specific and project-specific information is often required.

Section 7 of the Endangered Species Act **requires** Federal agencies to "request of the Secretary information whether any species which is listed or proposed to be listed may be present in the area of such proposed action" for any project that is conducted, permitted, funded, or licensed by any Federal agency. A letter from the local office and a species list which fulfills this requirement can **only** be obtained by requesting an official species list from either the Regulatory Review section in IPaC (see directions below) or from the local field office directly.

For project evaluations that require USFWS concurrence/review, please return to the IPaC website and request an official species list by doing the following:

1. Draw the project location and click CONTINUE.
2. Click DEFINE PROJECT.
3. Log in (if directed to do so).
4. Provide a name and description for your project.
5. Click REQUEST SPECIES LIST.

Listed species[1] and their critical habitats are managed by the Ecological Services Program of the U.S. Fish and Wildlife Service (USFWS) and the fisheries division of the National Oceanic and Atmospheric Administration (NOAA Fisheries[2]).

Species and critical habitats under the sole responsibility of NOAA Fisheries are **not** shown on this list. Please contact NOAA Fisheries for species under their jurisdiction.

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1. Species listed under the Endangered Species Act are threatened or endangered; IPaC also shows species that are candidates, or proposed, for listing. See the listing status page for more information. IPaC only shows species that are regulated by USFWS (see FAQ).
2. NOAA Fisheries, also known as the National Marine Fisheries Service (NMFS), is an office of the National Oceanic and Atmospheric Administration within the Department of Commerce.

The following species are potentially affected by activities in this location:

Mammals

NAME	STATUS
Riparian Brush Rabbit Sylvilagus bachmani riparius Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6189	Endangered
Riparian Woodrat (=san Joaquin Valley) Neotoma fuscipes riparia Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/6191	Endangered
Salt Marsh Harvest Mouse Reithrodontomys raviventris Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/613	Endangered
San Joaquin Kit Fox Vulpes macrotis mutica Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/2873	Endangered

Birds

NAME	STATUS
California Condor Gymnogyps californianus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/8193	Endangered
California Least Tern Sternula antillarum browni Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/8104	Endangered
California Ridgway''s Rail Rallus obsoletus obsoletus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4240	Endangered

Least Bell's Vireo Vireo bellii pusillus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/5945	Endangered
Yellow-billed Cuckoo Coccyzus americanus There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/3911	Threatened

Reptiles

NAME	STATUS
Alameda Whipsnake (=striped Racer) Masticophis lateralis euryxanthus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/5524	Threatened
Giant Garter Snake Thamnophis gigas Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/4482	Threatened
Northwestern Pond Turtle Actinemys marmorata Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1111	Proposed Threatened

Amphibians

NAME	STATUS
California Red-legged Frog Rana draytonii Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/2891	Threatened

California Tiger Salamander Ambystoma californiense | Threatened

There is **final** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/2076

Foothill Yellow-legged Frog Rana boylii | Threatened

There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/5133

Western Spadefoot Spea hammondii | Proposed Threatened

Wherever found

No critical habitat has been designated for this species.
https://ecos.fws.gov/ecp/species/5425

Fishes

NAME	STATUS
Delta Smelt Hypomesus transpacificus Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/321	Threatened
Longfin Smelt Spirinchus thaleichthys There is **proposed** critical habitat for this species. https://ecos.fws.gov/ecp/species/9011	Endangered
Longfin Smelt Spirinchus thaleichthys No critical habitat has been designated for this species.	Proposed Endangered

Insects

NAME	STATUS
Lange's Metalmark Butterfly Apodemia mormo langei Wherever found There is **proposed** critical habitat for this species. https://ecos.fws.gov/ecp/species/4382	Endangered

NAME	STATUS
Monarch Butterfly Danaus plexippus Wherever found There is **proposed** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/9743	Proposed Threatened
Valley Elderberry Longhorn Beetle Desmocerus californicus dimorphus Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/7850	Threatened

Crustaceans

NAME	STATUS
Conservancy Fairy Shrimp Branchinecta conservatio Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/8246	Endangered
Longhorn Fairy Shrimp Branchinecta longiantenna Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/4294	Endangered
Vernal Pool Fairy Shrimp Branchinecta lynchi Wherever found There is **final** critical habitat for this species. Your location overlaps the critical habitat. https://ecos.fws.gov/ecp/species/498	Threatened
Vernal Pool Tadpole Shrimp Lepidurus packardi Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/2246	Endangered

Flowering Plants

NAME	STATUS

Antioch Dunes Evening-primrose Oenothera deltoides ssp. howellii — Endangered

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/5970

Colusa Grass Neostapfia colusana — Threatened

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/5690

Contra Costa Goldfields Lasthenia conjugens — Endangered

Wherever found

There is **final** critical habitat for this species. Your location overlaps the critical habitat.
https://ecos.fws.gov/ecp/species/7058

Contra Costa Wallflower Erysimum capitatum var. angustatum — Endangered

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/7601

Fleshy Owl's-clover Castilleja campestris ssp. succulenta — Threatened

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/8095

Greene's Tuctoria Tuctoria greenei — Endangered

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/1573

Keck's Checker-mallow Sidalcea keckii — Endangered

Wherever found

There is **final** critical habitat for this species. Your location does not overlap the critical habitat.
https://ecos.fws.gov/ecp/species/5704

Large-flowered Fiddleneck Amsinckia grandiflora Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/5558	Endangered
Palmate-bracted Bird's Beak Cordylanthus palmatus Wherever found No critical habitat has been designated for this species. https://ecos.fws.gov/ecp/species/1616	Endangered
Soft Bird's-beak Cordylanthus mollis ssp. mollis Wherever found There is **final** critical habitat for this species. Your location does not overlap the critical habitat. https://ecos.fws.gov/ecp/species/8541	Endangered

Critical habitats

Potential effects to critical habitat(s) in this location must be analyzed along with the endangered species themselves.

This location overlaps the critical habitat for the following species:

NAME	TYPE
California Red-legged Frog Rana draytonii https://ecos.fws.gov/ecp/species/2891#crithab	Final
California Tiger Salamander Ambystoma californiense https://ecos.fws.gov/ecp/species/2076#crithab	Final
Contra Costa Goldfields Lasthenia conjugens https://ecos.fws.gov/ecp/species/7058#crithab	Final
Delta Smelt Hypomesus transpacificus https://ecos.fws.gov/ecp/species/321#crithab	Final
Longhorn Fairy Shrimp Branchinecta longiantenna https://ecos.fws.gov/ecp/species/4294#crithab	Final

Vernal Pool Fairy Shrimp Branchinecta lynchi Final
https://ecos.fws.gov/ecp/species/498#crithab

Bald & Golden Eagles

Bald and Golden Eagles are protected under the Bald and Golden Eagle Protection Act [2] and the Migratory Bird Treaty Act (MBTA) [1]. Any person or organization who plans or conducts activities that may result in impacts to Bald or Golden Eagles, or their nests, should follow appropriate regulations and implement required avoidance and minimization measures, as described in the various links on this page.

The data in this location indicates that no eagles have been observed in this area. This does not mean eagles are not present in your project area, especially if the area is difficult to survey. Please review the 'Steps to Take When No Results Are Returned' section of the Supplemental Information on Migratory Birds and Eagles document to determine if your project is in a poorly surveyed area. If it is, you may need to rely on other resources to determine if eagles may be present (e.g. your local FWS field office, state surveys, your own surveys).

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds https://www.fws.gov/sites/default/files/documents/nationwide-standard-conservation-measures.pdf
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Bald and Golden Eagle information is not available at this time

Bald & Golden Eagles FAQs

What does IPaC use to generate the potential presence of bald and golden eagles in my specified location?

The potential for eagle presence is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) which your project intersects, and that have been identified as warranting special attention because they are an eagle (Bald and Golden Eagle Protection Act requirements may apply).

Proper interpretation and use of your eagle report

On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort line or no data line (red horizontal) means a lack of data and, therefore, a lack of certainty about presence of the species. This list is not perfect; it is simply a starting point for identifying what birds have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide you in knowing when to implement avoidance and minimization measures to eliminate or reduce potential impacts from your project activities or get the appropriate permits should presence be confirmed.

How do I know if eagles are breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If an eagle on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your “IPaC PROBABILITY OF PRESENCE SUMMARY” at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()

Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()

Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Migratory birds

The Migratory Bird Treaty Act (MBTA) [1] prohibits the take (including killing, capturing, selling, trading, and transport) of protected migratory bird species without prior authorization by the Department of Interior U.S. Fish and Wildlife Service (FWS). The incidental take of migratory birds is the injury or death of birds that results from, but is not the purpose, of an activity. The FWS interprets the MBTA to prohibit incidental take.

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1. The Migratory Birds Treaty Act of 1918.
2. The Bald and Golden Eagle Protection Act of 1940.

Additional information can be found using the following links:

- Eagle Management https://www.fws.gov/program/eagle-management
- Measures for avoiding and minimizing impacts to birds https://www.fws.gov/library/collections/avoiding-and-minimizing-incidental-take-migratory-birds
- Nationwide avoidance and minimization measures for birds
- Supplemental Information for Migratory Birds and Eagles in IPaC https://www.fws.gov/media/supplemental-information-migratory-birds-and-bald-and-golden-eagles-may-occur-project-action

Migratory bird information is not available at this time

Migratory Bird FAQs

Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds.

Nationwide Avoidance & Minimization Measures for Birds describes measures that can help avoid and minimize impacts to all birds at any location year-round. When birds may be breeding in the area, identifying the locations of any active nests and avoiding their destruction is one of the most effective ways to minimize impacts. To see when birds are most likely to occur and breed in your project area, view the Probability of Presence Summary. Additional measures or permits may be advisable depending on the type of activity you are conducting and the type of infrastructure or bird species present on your project site.

What does IPaC use to generate the list of migratory birds that potentially occur in my specified location?

The Migratory Bird Resource List is comprised of Birds of Conservation Concern (BCC) and other species that may warrant special attention in your project location, such as those listed under the Endangered Species Act or the Bald and Golden Eagle Protection Act and those species marked as "Vulnerable". See the FAQ "What are the levels of concern for migratory birds?" for more information on the levels of concern covered in the IPaC migratory bird species list.

The migratory bird list generated for your project is derived from data provided by the Avian Knowledge Network (AKN). The AKN data is based on a growing collection of survey, banding, and citizen science datasets and is queried and filtered to return a list of those birds reported as occurring in the 10km grid cell(s) with which your project intersects. These species have been identified as warranting special attention because they are BCC species in that area, an eagle (Bald and Golden Eagle Protection Act requirements may apply), or a species that has a particular vulnerability to offshore activities or development.

Again, the Migratory Bird Resource list includes only a subset of birds that may occur in your project area. It is not representative of all birds that may occur in your project area. To get a list of all birds potentially present in your project area, and to verify survey effort when no results present, please visit the Rapid Avian Information Locator (RAIL) Tool.

Why are subspecies showing up on my list?

Subspecies profiles are included on the list of species present in your project area because observations in the AKN for **the species** are being detected. If the species are present, that means that the subspecies may also be present. If a subspecies shows up on your list, you may need to rely on other resources to determine if that subspecies may be present (e.g. your local FWS field office, state surveys, your own surveys).

What does IPaC use to generate the probability of presence graphs for the migratory birds potentially occurring in my specified location?

The probability of presence graphs associated with your migratory bird list are based on data provided by the Avian Knowledge Network (AKN). This data is derived from a growing collection of survey, banding, and citizen science datasets.

Probability of presence data is continuously being updated as new and better information becomes available. To learn more about how the probability of presence graphs are produced and how to interpret them, go to the Probability of Presence Summary and then click on the "Tell me about these graphs" link.

How do I know if a bird is breeding, wintering, or migrating in my area?

To see what part of a particular bird's range your project area falls within (i.e. breeding, wintering, migrating, or resident), you may query your location using the RAIL Tool and view the range maps provided for birds in your area at the bottom of the profiles provided for each bird in your results. If a bird on your IPaC migratory bird species list has a breeding season associated with it (indicated by yellow vertical bars on the phenology graph in your "IPaC PROBABILITY OF PRESENCE SUMMARY" at the top of your results list), there may be nests present at some point within the timeframe specified. If "Breeds elsewhere" is indicated, then the bird likely does not breed in your project area.

What are the levels of concern for migratory birds?

Migratory birds delivered through IPaC fall into the following distinct categories of concern:

1. "BCC Rangewide" birds are Birds of Conservation Concern (BCC) that are of concern throughout their range anywhere within the USA (including Hawaii, the Pacific Islands, Puerto Rico, and the Virgin Islands);
2. "BCC - BCR" birds are BCCs that are of concern only in particular Bird Conservation Regions (BCRs) in the continental USA; and
3. "Non-BCC - Vulnerable" birds are not BCC species in your project area, but appear on your list either because of the Bald and Golden Eagle Protection Act requirements (for eagles) or (for non-eagles) potential susceptibilities in offshore areas from certain types of development or activities (e.g. offshore energy development or longline fishing).

Although it is important to avoid and minimize impacts to all birds, efforts should be made, in particular, to avoid and minimize impacts to the birds on this list, especially BCC species. For more information on avoidance and minimization measures you can implement to help avoid and minimize migratory bird impacts, please see the FAQ “Tell me more about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds”.

Details about birds that are potentially affected by offshore projects

For additional details about the relative occurrence and abundance of both individual bird species and groups of bird species within your project area off the Atlantic Coast, please visit the Northeast Ocean Data Portal. The Portal also offers data and information about other taxa besides birds that may be helpful to you in your project review. Alternately, you may download the bird model results files underlying the portal maps through the NOAA NCCOS Integrative Statistical Modeling and Predictive Mapping of Marine Bird Distributions and Abundance on the Atlantic Outer Continental Shelf project webpage.

Proper interpretation and use of your migratory bird report

The migratory bird list generated is not a list of all birds in your project area, only a subset of birds of priority concern. To learn more about how your list is generated and see options for identifying what other birds may be in your project area, please see the FAQ "What does IPaC use to generate the migratory birds potentially occurring in my specified location". Please be aware this report provides the "probability of presence" of birds within the 10 km grid cell(s) that overlap your project; not your exact project footprint. On the graphs provided, please look carefully at the survey effort (indicated by the black vertical line) and for the existence of the "no data" indicator (a red horizontal line). A high survey effort is the key component. If the survey effort is high, then the probability of presence score can be viewed as more dependable. In contrast, a low survey effort bar or no data bar means a lack of data and, therefore, a lack of certainty about presence of the species. This list does not represent all birds present in your project area. It is simply a starting point for identifying what birds of concern have the potential to be in your project area, when they might be there, and if they might be breeding (which means nests might be present). The list and associated information help you know what to look for to confirm presence and helps guide implementation of avoidance and minimization measures to eliminate or reduce potential impacts from your project activities, should presence be confirmed. To learn more about avoidance and minimization measures, visit the FAQ "Tell me about avoidance and minimization measures I can implement to avoid or minimize impacts to migratory birds".

Interpreting the Probability of Presence Graphs

Each green bar represents the bird's relative probability of presence in the 10km grid cell(s) your project overlaps during a particular week of the year. A taller bar indicates a higher probability of species presence. The survey effort can be used to establish a level of confidence in the presence score.

How is the probability of presence score calculated? The calculation is done in three steps:

The probability of presence for each week is calculated as the number of survey events in the week where the species was detected divided by the total number of survey events for that week. For example, if in week 12 there were 20 survey events and the Spotted Towhee was found in 5 of them, the probability of presence of the Spotted Towhee in week 12 is 0.25.

To properly present the pattern of presence across the year, the relative probability of presence is calculated. This is the probability of presence divided by the maximum probability of presence across all weeks. For example, imagine the probability of presence in week 20 for the Spotted Towhee is 0.05, and that the probability of presence at week 12 (0.25) is the maximum of any week of the year. The relative probability of presence on week 12 is 0.25/0.25 = 1; at week 20 it is 0.05/0.25 = 0.2.

The relative probability of presence calculated in the previous step undergoes a statistical conversion so that all possible values fall between 0 and 10, inclusive. This is the probability of presence score.

Breeding Season ()
Yellow bars denote a very liberal estimate of the time-frame inside which the bird breeds across its entire range. If there are no yellow bars shown for a bird, it does not breed in your project area.

Survey Effort ()
Vertical black lines superimposed on probability of presence bars indicate the number of surveys performed for that species in the 10km grid cell(s) your project area overlaps.

No Data ()
A week is marked as having no data if there were no survey events for that week.

Survey Timeframe
Surveys from only the last 10 years are used in order to ensure delivery of currently relevant information. The exception to this is areas off the Atlantic coast, where bird returns are based on all years of available data, since data in these areas is currently much more sparse.

Facilities

National Wildlife Refuge lands

Any activity proposed on lands managed by the National Wildlife Refuge system must undergo a 'Compatibility Determination' conducted by the Refuge. Please contact the individual Refuges to discuss any questions or concerns.

There are no refuge lands at this location.

Fish hatcheries

There are no fish hatcheries at this location.

Wetlands in the National Wetlands Inventory (NWI)

Impacts to NWI wetlands and other aquatic habitats may be subject to regulation under Section 404 of the Clean Water Act, or other State/Federal statutes.

For more information please contact the Regulatory Program of the local U.S. Army Corps of Engineers District.

Wetland information is not available at this time

This can happen when the National Wetlands Inventory (NWI) map service is unavailable, or for very large projects that intersect many wetland areas. Try again, or visit the NWI map to view wetlands at this location.

Data limitations

The Service's objective of mapping wetlands and deepwater habitats is to produce reconnaissance level information on the location, type and size of these resources. The maps are prepared from the analysis of high altitude imagery. Wetlands are identified based on vegetation, visible hydrology and geography. A margin of error is inherent in the use of imagery; thus, detailed on-the-ground inspection of any particular site may result in revision of the wetland boundaries or classification established through image analysis.

The accuracy of image interpretation depends on the quality of the imagery, the experience of the image analysts, the amount and quality of the collateral data and the amount of ground truth verification work conducted. Metadata should be consulted to determine the date of the source imagery used and any mapping problems.

Wetlands or other mapped features may have changed since the date of the imagery or field work. There may be occasional differences in polygon boundaries or classifications between the information depicted on the map and the actual conditions on site.

Data exclusions

Certain wetland habitats are excluded from the National mapping program because of the limitations of aerial imagery as the primary data source used to detect wetlands. These habitats include seagrasses or submerged aquatic vegetation that are found in the intertidal and subtidal zones of estuaries and nearshore coastal waters. Some deepwater reef communities (coral or tuberficid worm reefs) have also been excluded from the inventory. These habitats, because of their depth, go undetected by aerial imagery.

Data precautions

Federal, state, and local regulatory agencies with jurisdiction over wetlands may define and describe wetlands in a different manner than that used in this inventory. There is no attempt, in either the design or products of this inventory, to define the limits of proprietary jurisdiction of any Federal, state, or local government or to establish the geographical scope of the regulatory programs of government agencies. Persons intending to engage in activities involving modifications within or adjacent to wetland areas should seek the advice of appropriate Federal, state, or local agencies concerning specified agency regulatory programs and proprietary jurisdictions that may affect such activities.

Selected Elements by Scientific Name

California Department of Fish and Wildlife

California Natural Diversity Database

Query Criteria: (Federal Listing Status IS (Endangered OR Threatened OR Proposed Endangered OR Proposed Threatened OR Candidate) OR State Listing Status IS (Endangered OR Threatened OR Rare OR Candidate Endangered OR Candidate Threatened))
 AND County IS (Sacramento OR San Joaquin)

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Acipenser medirostris pop. 1 green sturgeon - southern DPS	AFCAA01031	Threatened	None	G2T1	S1	SSC
Actinemys marmorata northwestern pond turtle	ARAAD02031	Proposed Threatened	None	G2	SNR	SSC
Agelaius tricolor tricolored blackbird	ABPBXB0020	None	Threatened	G1G2	S2	SSC
Ambystoma californiense pop. 1 California tiger salamander - central California DPS	AAAAA01181	Threatened	Threatened	G2G3T3	S3	WL
Amsinckia grandiflora large-flowered fiddleneck	PDBOR01050	Endangered	Endangered	G1	S1	1B.1
Athene cunicularia burrowing owl	ABNSB10010	None	Candidate Endangered	G4	S2	SSC
Bombus crotchii Crotch's bumble bee	IIHYM24480	None	Candidate Endangered	G2	S2	
Bombus occidentalis western bumble bee	IIHYM24252	None	Candidate Endangered	G3	S1	
Branchinecta lynchi vernal pool fairy shrimp	ICBRA03030	Threatened	None	G3	S3	
Buteo swainsoni Swainson's hawk	ABNKC19070	None	Threatened	G5	S4	
Castilleja campestris var. succulenta succulent owl's-clover	PDSCR0D3Z1	Threatened	Endangered	G4?T2T3	S2S3	1B.2
Chloropyron molle ssp. molle soft salty bird's-beak	PDSCR0J0D2	Endangered	Rare	G2T1	S1	1B.2
Chloropyron palmatum palmate-bracted bird's-beak	PDSCR0J0J0	Endangered	Endangered	G1	S1	1B.1
Coccyzus americanus occidentalis western yellow-billed cuckoo	ABNRB02022	Threatened	Endangered	G5T2T3	S1	
Desmocerus californicus dimorphus valley elderberry longhorn beetle	IICOL48011	Threatened	None	G3T3	S3	
Eryngium racemosum Delta button-celery	PDAPI0Z0S0	None	Endangered	G1	S1	1B.1
Gratiola heterosepala Boggs Lake hedge-hyssop	PDSCR0R060	None	Endangered	G2	S2	1B.2
Haliaeetus leucocephalus bald eagle	ABNKC10010	Delisted	Endangered	G5	S3	FP

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Hypomesus transpacificus Delta smelt	AFCHB01040	Threatened	Endangered	G1	S1	
Laterallus jamaicensis coturniculus California black rail	ABNME03041	None	Threatened	G3T1	S2	FP
Lepidurus packardi vernal pool tadpole shrimp	ICBRA10010	Endangered	None	G3	S3	
Lilaeopsis masonii Mason's lilaeopsis	PDAPI19030	None	Rare	G2	S2	1B.1
Masticophis lateralis euryxanthus Alameda whipsnake	ARADB21031	Threatened	Threatened	G4T2	S2	
Neotoma fuscipes riparia riparian (=San Joaquin Valley) woodrat	AMAFF08081	Endangered	None	G5T1	S1	SSC
Oenothera deltoides ssp. howellii Antioch Dunes evening-primrose	PDONA0C0B4	Endangered	Endangered	G5T1	S1	1B.1
Oncorhynchus mykiss irideus pop. 11 steelhead - Central Valley DPS	AFCHA0209K	Threatened	None	G5T2Q	S2	SSC
Orcuttia tenuis slender Orcutt grass	PMPOA4G050	Threatened	Endangered	G2	S2	1B.1
Orcuttia viscida Sacramento Orcutt grass	PMPOA4G070	Endangered	Endangered	G1	S1	1B.1
Rana boylii pop. 4 foothill yellow-legged frog - central coast DPS	AAABH01054	Threatened	Endangered	G3T2	S2	
Rana boylii pop. 5 foothill yellow-legged frog - south Sierra DPS	AAABH01055	Endangered	Endangered	G3T2	S2	
Rana draytonii California red-legged frog	AAABH01022	Threatened	None	G2G3	S2S3	SSC
Reithrodontomys raviventris salt-marsh harvest mouse	AMAFF02040	Endangered	Endangered	G1G2	S3	FP
Riparia riparia bank swallow	ABPAU08010	None	Threatened	G5	S3	
Spea hammondii western spadefoot	AAABF02020	Proposed Threatened	None	G2G3	S3S4	SSC
Spirinchus thaleichthys pop. 2 longfin smelt - San Francisco Bay-Delta DPS	AFCHB03040	Endangered	Threatened	G5TNRQ	S1	
Sylvilagus bachmani riparius riparian brush rabbit	AMAEB01021	Endangered	Endangered	G5T1	S2	
Thamnophis gigas giant gartersnake	ARADB36150	Threatened	Threatened	G2	S2	
Tuctoria greenei Greene's tuctoria	PMPOA6N010	Endangered	Rare	G1	S1	1B.1
Vireo bellii pusillus least Bell's vireo	ABPBW01114	Endangered	Endangered	G5T2	S3	

Species	Element Code	Federal Status	State Status	Global Rank	State Rank	Rare Plant Rank/CDFW SSC or FP
Vulpes macrotis mutica San Joaquin kit fox	AMAJA03041	Endangered	Threatened	G4T2	S3	

Record Count: 40

APPENDIX E

Air Quality Modeling Data

Road Construction Emissions Model, Version 9.0.0

Daily Emission Estimates for -> 14 Mile Pump Project Phases (Pounds)	ROG (lbs/day)	CO (lbs/day)	NOx (lbs/day)	Total PM10 (lbs/day)	Exhaust PM10 (lbs/day)	Fugitive Dust PM10 (lbs/day)	Total PM2.5 (lbs/day)	Exhaust PM2.5 (lbs/day)	Fugitive Dust PM2.5 (lbs/day)	SOx (lbs/day)	CO2 (lbs/day)	CH4 (lbs/day)	N2O (lbs/day)	CO2e (lbs/day)
Grubbing/Land Clearing	0.94	16.91	3.00	20.14	0.14	20.00	4.26	0.10	4.16	0.03	2,908.00	0.85	0.03	2,938.63
Grading/Excavation	0.00	0.00	0.00	20.00	0.00	20.00	4.16	0.00	4.16	0.00	0.00	0.00	0.00	0.00
Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	20.00	0.00	20.00	4.16	0.00	4.16	0.00	0.00	0.00	0.00	0.00
Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum (pounds/day)	0.94	16.91	3.00	20.14	0.14	20.00	4.26	0.10	4.16	0.03	2,908.00	0.85	0.03	2,938.63
Total (tons/construction project)	0.01	0.22	0.04	2.25	0.00	2.24	0.47	0.00	0.47	0.00	38.39	0.01	0.00	38.79

Notes:

Project Start Year ->	2026
Project Length (months) ->	12
Total Project Area (acres) ->	104
Maximum Area Disturbed/Day (acres) ->	2
Water Truck Used? ->	Yes

	Total Material Imported/Exported Volume (yd^3/day)		Daily VMT (miles/day)			
Phase	Soil	Asphalt	Soil Hauling	Asphalt Hauling	Worker Commute	Water Truck
Grubbing/Land Clearing	0	0	0	0	500	0
Grading/Excavation	0	0	0	0	0	0
Drainage/Utilities/Sub-Grade	0	0	0	0	0	0
Paving	0	0	0	0	0	0

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns G and H. Total PM2.5 emissions shown in Column I are the sum of exhaust and fugitive dust emissions shown in columns J and K.

CO2e emissions are estimated by multiplying mass emissions for each GHG by its global warming potential (GWP), 1 , 25 and 298 for CO2, CH4 and N2O, respectively. Total CO2e is then estimated by summing CO2e estimates over all GHGs.

Total Emission Estimates by Phase for -> 14 Mile Pump Project Phases (Tons for all except CO2e. Metric tonnes for CO2e)	ROG (tons/phase)	CO (tons/phase)	NOx (tons/phase)	Total PM10 (tons/phase)	Exhaust PM10 (tons/phase)	Fugitive Dust PM10 (tons/phase)	Total PM2.5 (tons/phase)	Exhaust PM2.5 (tons/phase)	Fugitive Dust PM2.5 (tons/phase)	SOx (tons/phase)	CO2 (tons/phase)	CH4 (tons/phase)	N2O (tons/phase)	CO2e (MT/phase)
Grubbing/Land Clearing	0.01	0.22	0.04	0.27	0.00	0.26	0.06	0.00	0.05	0.00	38.39	0.01	0.00	35.19
Grading/Excavation	0.00	0.00	0.00	1.06	0.00	1.06	0.22	0.00	0.22	0.00	0.00	0.00	0.00	0.00
Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.92	0.00	0.92	0.19	0.00	0.19	0.00	0.00	0.00	0.00	0.00
Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Maximum (tons/phase)	0.01	0.22	0.04	1.06	0.00	1.06	0.22	0.00	0.22	0.00	38.39	0.01	0.00	35.19
Total (tons/construction project)	0.01	0.22	0.04	2.25	0.00	2.24	0.47	0.00	0.47	0.00	38.39	0.01	0.00	35.19

PM10 and PM2.5 estimates assume 50% control of fugitive dust from watering and associated dust control measures if a minimum number of water trucks are specified.

Total PM10 emissions shown in column F are the sum of exhaust and fugitive dust emissions shown in columns G and H. Total PM2.5 emissions shown in Column I are the sum of exhaust and fugitive dust emissions shown in columns J and K.

CO2e emissions are estimated by multiplying mass emissions for each GHG by its global warming potential (GWP), 1 , 25 and 298 for CO2, CH4 and N2O, respectively. Total CO2e is then estimated by summing CO2e estimates over all GHGs.

The CO2e emissions are reported as metric tons per phase.

Road Construction Emissions Model **Version 9.0.0**

Data Entry Worksheet

Note: Required data input sections have a yellow background.
Optional data input sections have a blue background. Only areas with a yellow or blue background can be modified. Program defaults have a white background.
The user is required to enter information in cells D10 through D24, E28 through G35, and D38 through D41 for all project types.
Please use "Clear Data Input & User Overrides" button first before changing the Project Type or begin a new project.

Clear Data Input & User Overrides

To begin a new project, click this button to clear data previously entered. This button will only work if you opted not to disable macros when loading this spreadsheet.

SACRAMENTO METROPOLITAN AIR QUALITY MANAGEMENT DISTRICT

Input Type

Project Name	14 Mile Pump	
Construction Start Year	2026	Enter a Year between 2014 and 2040 (inclusive)
Project Type For 4: Other Linear Project Type, please provide project specific off-road equipment population and vehicle trip data	4	1) New Road Construction : Project to build a roadway from bare ground, which generally requires more site preparation than widening an existing roadway 2) Road Widening : Project to add a new lane to an existing roadway 3) Bridge/Overpass Construction : Project to build an elevated roadway, which generally requires some different equipment than a new roadway, such as a crane 4) Other Linear Project Type: Non-roadway project such as a pipeline, transmission line, or levee construction
Project Construction Time	12.00	months
Working Days per Month	22.00	days (assume 22 if unknown)
Predominant Soil/Site Type: Enter 1, 2, or 3 (for project within "Sacramento County", follow soil type selection instructions in cells E18 to E20 otherwise see instructions provided in cells J18 to J22)	1	1) Sand Gravel : Use for quaternary deposits (Delta/West County) 2) Weathered Rock-Earth : Use for Laguna formation (Jackson Highway area) or the Ione formation (Scott Road, Rancho Murieta) 3) Blasted Rock : Use for Salt Springs Slate or Copper Hill Volcanics (Folsom South of Highway 50, Rancho Murieta)
Project Length	1.00	mile
Total Project Area	104.00	acres
Maximum Area Disturbed/Day	2.00	acres
Water Trucks Used?	1	1. Yes 2. No

Please note that the soil type instructions provided in cells E18 to E20 are specific to Sacramento County. Maps available from the California Geologic Survey (see weblink below) can be used to determine soil type outside Sacramento County.

http://www.conservation.ca.gov/cgs/information/geologic_mapping/Pages/googlemaps.aspx#regionalseries

Material Hauling Quantity Input

Material Type	Phase	Haul Truck Capacity (yd^3) (assume 20 if unknown)	Import Volume (yd^3/day)	Export Volume (yd^3/day)
Soil	Grubbing/Land Clearing	20.00	0.00	0.00
	Grading/Excavation			
	Drainage/Utilities/Sub-Grade			
	Paving			
Asphalt	Grubbing/Land Clearing			
	Grading/Excavation			
	Drainage/Utilities/Sub-Grade			
	Paving			

Mitigation Options

On-road Fleet Emissions Mitigation	2010 and Newer On-road Vehicles Fleet	Select "2010 and Newer On-road Vehicles Fleet" option when the on-road heavy-duty truck fleet for the project will be limited to vehicles of model year 2010 or newer
Off-road Equipment Emissions Mitigation	Tier 4 Equipment	Select "20% NOx and 45% Exhaust PM reduction" option if the project will be required to use a lower emitting off-road construction fleet. The SMAQMD Construction Mitigation Calculator can be used to confirm compliance with this mitigation measure (http://www.airquality.org/Businesses/CEQA-Land-Use-Planning/Mitigation). Select "Tier 4 Equipment" option if some or all off-road equipment used for the project meets CARB Tier 4 Standard
Will all off-road equipment be tier 4?	All Tier 4 Equipment	

The remaining sections of this sheet contain areas that require modification when 'Other Project Type' is selected.

Note: The program's estimates of construction period phase length can be overridden in cells D50 through D53, and F50 through F53.

Construction Periods	User Override of Construction Months	Program Calculated Months	User Override of Phase Starting Date	Program Default Phase Starting Date
Grubbing/Land Clearing		1.20		1/1/2026
Grading/Excavation		4.80		2/7/2026
Drainage/Utilities/Sub-Grade		4.20		7/3/2026
Paving		1.80		11/8/2026
Totals (Months)	12			

Soil Hauling Emissions	User Override of Miles/Round Trip	Program Estimate of Miles/Round Trip	User Override of Truck Round Trips/Day	Default Values Round Trips/Day	Calculated Daily VMT
User Input					
Miles/round trip: Grubbing/Land Clearing				0	0.00
Miles/round trip: Grading/Excavation				0	0.00
Miles/round trip: Drainage/Utilities/Sub-Grade				0	0.00
Miles/round trip: Paving				0	0.00

2010+ Model Year Mitigation Option Emission Rates	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Grubbing/Land Clearing (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Grading/Excavation (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Draining/Utilities/Sub-Grade (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Paving (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,651.74	0.00	0.26	1,729.14
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Hauling Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total tons per construction project	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Note: Asphalt Hauling emission default values can be overridden in cells D91 through D94, and F91 through F94.

Asphalt Hauling Emissions	User Override of Miles/Round Trip	Program Estimate of Miles/Round Trip	User Override of Truck Round Trips/Day	Default Values Round Trips/Day	Calculated Daily VMT
User Input					
Miles/round trip: Grubbing/Land Clearing				0	0.00
Miles/round trip: Grading/Excavation				0	0.00
Miles/round trip: Drainage/Utilities/Sub-Grade				0	0.00
Miles/round trip: Paving				0	0.00

2010+ Model Year Mitigation Option Emission Rates	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Grubbing/Land Clearing (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Grading/Excavation (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Draining/Utilities/Sub-Grade (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Paving (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,651.74	0.00	0.26	1,729.14
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total tons per construction project	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Worker Commute Emissions

User Input	User Override of Worker Commute Default Values	Default Values	Calculated Daily Trips	Calculated Daily VMT
Miles/ one-way trip	10			
One-way trips/day	10			
No. of employees: Grubbing/Land Clearing	5		50	500.00
No. of employees: Grading/Excavation			0	0.00
No. of employees: Drainage/Utilities/Sub-Grade	0		0	0.00
No. of employees: Paving	0		0	0.00

Emission Rates	ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grubbing/Land Clearing (grams/mile)	0.01	0.72	0.05	0.05	0.02	0.00	285.85	0.00	0.01	287.41
Grading/Excavation (grams/mile)	0.01	0.72	0.05	0.05	0.02	0.00	285.85	0.00	0.01	287.41
Draining/Utilities/Sub-Grade (grams/mile)	0.01	0.72	0.05	0.05	0.02	0.00	285.85	0.00	0.01	287.41
Paving (grams/mile)	0.01	0.72	0.05	0.05	0.02	0.00	285.55	0.00	0.01	287.11
Grubbing/Land Clearing (grams/trip)	0.87	2.47	0.23	0.00	0.00	0.00	61.59	0.06	0.03	71.10
Grading/Excavation (grams/trip)	0.87	2.47	0.23	0.00	0.00	0.00	61.59	0.06	0.03	71.10
Draining/Utilities/Sub-Grade (grams/trip)	0.87	2.47	0.23	0.00	0.00	0.00	61.59	0.06	0.03	71.10
Paving (grams/trip)	0.87	2.47	0.23	0.00	0.00	0.00	61.53	0.06	0.03	71.02
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.11	1.07	0.08	0.05	0.02	0.00	321.88	0.01	0.01	324.65
Tons per const. Period - Grubbing/Land Clearing	0.00	0.01	0.00	0.00	0.00	0.00	4.25	0.00	0.00	4.29
Pounds per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total tons per construction project	0.00	0.01	0.00	0.00	0.00	0.00	4.25	0.00	0.00	4.29

Note: Water Truck default values can be overridden in cells D153 through D156, I153 through I156, and F153 through F156.

Water Truck Emissions

User Input	User Override of Default # Water Trucks	Program Estimate of Number of Water Trucks	User Override of Truck Round Trips/Vehicle/Day	Default Values Round Trips/Vehicle/Day	Calculated Trips/day	User Override of Miles/Round Trip	Default Values Miles/Round Trip	Calculated Daily VMT
Grubbing/Land Clearing - Exhaust								0.00
Grading/Excavation - Exhaust								0.00
Drainage/Utilities/Subgrade								0.00
Paving								0.00

2010+ Model Year Mitigation Option Emission Rates	ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grubbing/Land Clearing (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Grading/Excavation (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Draining/Utilities/Sub-Grade (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,652.48	0.00	0.26	1,729.92
Paving (grams/mile)	0.03	0.41	3.10	0.11	0.05	0.02	1,651.74	0.00	0.26	1,729.14
Grubbing/Land Clearing (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Grading/Excavation (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Draining/Utilities/Sub-Grade (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Paving (grams/trip)	0.00	0.00	4.47	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Emissions	**ROG**	**CO**	**NOx**	**PM10**	**PM2.5**	**SOx**	**CO2**	**CH4**	**N2O**	**CO2e**
Pounds per day - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grubbing/Land Clearing	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Grading/Excavation	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Drainage/Utilities/Sub-Grade	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Pounds per day - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Tons per const. Period - Paving	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
Total tons per construction project	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

Off-Road Equipment Emissions

Grubbing/Land Clearing Override of Default Number of Vehicles	Default Number of Vehicles *Program-estimate*	Mitigation Option Override of Default Equipment Tier (applicable only when "Tier 4 Mitigation" Option Selected)	Default Equipment Tier	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	SOx pounds/day	CO2 pounds/day	CH4 pounds/day	N2O pounds/day	CO2e pounds/day
			Tier 4	Aerial Lifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Air Compressors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Bore/Drill Rigs	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Cement and Mortar Mixers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Concrete/Industrial Saws	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Cranes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Crawler Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Crushing/Proc. Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00			Tier 4	Excavators	0.16	3.92	0.32	0.02	0.01	0.01	500.34	0.16	0.00	505.73
			Tier 4	Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Generator Sets	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Graders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Off-Highway Tractors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00			Tier 4	Off-Highway Trucks	0.40	7.00	0.81	0.04	0.04	0.01	1,279.68	0.41	0.01	1,293.45
			Tier 4	Other Construction Equipmei	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Other General Industrial Equip	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Other Material Handling Equip	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Pavers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Paving Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Plate Compactors	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Pressure Washers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Pumps	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Rollers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Rough Terrain Forklifts	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Rubber Tired Dozers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00			Tier 4	Rubber Tired Loaders	0.19	3.35	0.39	0.02	0.02	0.01	605.62	0.20	0.01	612.16
			Tier 4	Scrapers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Signal Boards	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
1.00			Tier 4	Skid Steer Loaders	0.08	1.57	1.41	0.01	0.01	0.00	200.48	0.06	0.00	202.64
			Tier 4	Surfacing Equipment	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Sweepers/Scrubbers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Tractors/Loaders/Backhoes	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Trenchers	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
			Tier 4	Welders	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

User-Defined Off-road Equipment If non-default vehicles are used, please provide information in 'Non-default Off-road Equipment' tab

Number of Vehicles	Equipment Tier	Type	ROG pounds/day	CO pounds/day	NOx pounds/day	PM10 pounds/day	PM2.5 pounds/day	SOx pounds/day	CO2 pounds/day	CH4 pounds/day	N2O pounds/day	CO2e pounds/day
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
0.00	N/A	0	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00

		ROG	CO	NOx	PM10	PM2.5	SOx	CO2	CH4	N2O	CO2e
Grubbing/Land Clearing	pounds per day	0.83	15.84	2.92	0.08	0.08	0.03	2,586.11	0.84	0.02	2,613.98
Grubbing/Land Clearing	tons per phase	0.01	0.21	0.04	0.00	0.00	0.00	34.14	0.01	0.00	34.50

Barge Emissions

SMAQMD Harborcraft, Dredge and Barge Emission Factor Calculator - Input Data Page

INSTRUCTIONS:
1. Enter inputs into tables A1, A2, A3, and A4 below. Required inputs must be entered to estimate emission rates, optional inputs should be entered if available.
2. After entering inputs, review status and error messages (cell E14); make changes as necessary until this cell is green indicating that inputs are ready.
3. Results may be reviewed in "MainEngineEmissRates" and "AuxEngineEmissRates" tabs, both colored yellow.

Inputs and Status

Inputs color legend	Required Input Optional Input
Status and error messages	ERROR! All entries have to be in consecutive rows and all required inputs provided aux engine table (A3)

A4. Project Information

Inputs	
Date (mm/dd/yyyy):	4/1/2026
Project Name:	In River/on River
Project Location:	LSJR
Contact Person:	
Company Name:	
Mailing Address:	
Phone Number:	
Email Address:	

This information is only optional if the tool is being used for planning purposes. If using for construction mitigation, the user is required to provide this information

A1. Inventory Calendar year

Inventory Calendar Year	2026

This information is only optional if the tool is being used for planning purposes. If using for construction mitigation, the user is required to provide this information

A2. Main Engine Inputs

Required Inputs			**Optional Inputs**			
Vessel Name	**Vessel Type**	**No. of Engines**	**Engine Model Year**	**Engine Rated Power (hp)**	**Vessel Number**	**Home Port**
Tug	Tug Boats	1	2014			

A3. Auxiliary Engine Inputs

Required Inputs			**Optional Inputs**	
Vessel Name	**Auxiliary Engine Type**	**No. of Engines**	**Engine Model Year**	**Engine Rated Power (hp)**
	Tow Boats / Push Boats Generator		2014	

Calendar Y 2026 **Number of Entries:** 1

Vessel/Engine Information							
Vessel Name	Vessel Number	Home Port	Vessel Type	Engine Model Year	Engine Rated Power (hp)	Engine Load Factor	Number of engines
Tug			Tug Boats	2014	1167	0.50	1

Vessel Name	Emission Rates (lb/hr; estimates for each row are totals over the number of engines listed in column J for that row)									
	PM_{10}	$PM_{2.5}$	NOx	ROG	CO	SO_2	CO_2	CH_4	N_2O	CO_2e
Tug	0.121	0.109	5.581	0.788	5.485	0.007	760.559	0.031	0.006	763.169

Vessel Name	Emission Rates for a Single Engine (g/bhp-hr)									
	PM_{10}	$PM_{2.5}$	NOx	ROG	CO	SO_2	CO_2	CH_4	N_2O	CO_2e
Tug	0.094	0.085	4.337	0.613	4.263	0.006	591.045	0.024	0.005	593.1

Site	PM10	PM 2.5	Nox	ROG	CO	SO2	Hours
Barge lb/hr	0.121	0.109	5.581	0.788	5.485	0.007	1
On River tons	0.000968	0.0009	0.0446	0.0063	0.0439	0.0001	16
In River tons	0.0010	0.0009	0.0446	0.0063	0.0439	0.0001	16

Barge emissions calculated in lb/hr site emissions are in tons estimated by project

APPENDIX F

General Best Management Practices (BMPs)

General Best Management Practices (BMPs)

The following measures listed below are general best management practices (BMPs) and standard actions that would be implemented to avoid and minimize impacts from construction related activities.

1. Prior to commencing construction activities, contractor and all employees must participate in an all-employee USACE conducted environmental awareness education program describing resources of concern, areas to be avoided and possible penalties for noncompliance.
2. Stage equipment, materials, supplies and vehicles on hardscape or other improved surface outside any environmentally sensitive areas.
3. All equipment and vehicles entering the project area and/or traveling between project areas must be cleaned of dirt and debris capable of transporting invasive species.
4. Refuel equipment and vehicles outside the project area.
5. Operate equipment and vehicles from hardscape, existing two track or other improved access route.
6. Chemicals, lubricants, drilling additives, and other hazardous materials used in operation must have 110% containment.
7. Completely capture and remove waste and dispose of properly off-site.
8. In work areas near down gradient aquatic resources, implement erosion control measures (BMPs) that minimize soil, sediment, or other waste from reaching the aquatic resources.
9. Limit site access to the smallest area possible in order to minimize disturbance.
10. Remove litter, debris, unused materials, equipment, and supplies from the project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
11. Immediately clean up and report (within 24 hours) any spills of hazardous materials to the USACE POC. Report any such spills, and the success of the efforts to clean them up, in post-construction compliance reports.
12. If a contractor incidentally harms a living, or finds a dead, injured, or entrapped, threatened or endangered species or any other spices report the incident immediately to the USACE POC.

13. Storm Water Protection BMPS are to be in place prior to the start of construction and to be maintained throughout construction. Any Storm Water Protection Items that are being utilized must follow CASQA guidance.

Specific Resource Area BMPs

For the resource areas discussed in detail in the SEA, specific BMPs and mitigation measures relating to each resource are listed in this section and include both NEPA and CEQA mitigation measures referenced from the 2018 LSJR IIFR/EIS/EIR and the 2023 TS30L Final SEIR.

Soils and Mineral Resources

NEPA Mitigation Measures

Section 5.3.5 in the 2018 LSJR IIFR/EIS/EIR references no mitigation required. However, the general BMPs listed here and in the SEA would be implemented.

CEQA Mitigation Measures

Mitigation Measure 3.7-4 in the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.7-4: Preconstruction Training and Paleontological Monitoring. Prior to the start of construction activities, USACE shall retain a Qualified Paleontologist who meets the standards of the Society for Vertebrate Paleontology (SVP 2010) to carry out all mitigation measures related to paleontological resources. Prior to the start of any ground-disturbing activities, the Qualified Paleontologist shall conduct preconstruction worker paleontological resources sensitivity training. The training shall include information on what types of paleontological resources could be encountered during excavations, what to do in case an unanticipated discovery is made by a worker, and laws protecting paleontological resources. All construction personnel shall be informed of the possibility of encountering fossils and instructed to immediately inform the construction foreman or supervisor if any bones or other potential fossils are unexpectedly unearthed in an area where a paleontological monitor is not present. The Applicant shall ensure that construction personnel are made available for and attend the training and retain documentation demonstrating attendance.

The Qualified Paleontologist shall supervise a paleontological monitor meeting the Society for Vertebrate Paleontology standards (SVP 2010) who shall be present during all excavations in the Modesto Formation. Monitoring shall consist of visually inspecting fresh exposures of rock for larger fossil remains and, where appropriate, collecting wet or dry screened standard sediment samples (up to 4.0 cubic yards) of promising horizons for smaller fossil remains (SVP 2010). Depending on the conditions encountered, full-time monitoring can be reduced to part-time inspections or ceased entirely if determined adequate by the Qualified Paleontologist. The Qualified Paleontologist may spot check the excavation on an intermittent basis and recommend whether the depth of required monitoring should be revised based on his/her observations. Monitoring activities shall be documented in a Paleontological Resources Monitoring Report to be prepared by the Qualified Paleontologist at the completion of construction.

If a paleontological resource is discovered during construction, the paleontological monitor shall be empowered to temporarily divert or redirect grading and excavation activities in the area of the exposed resource to facilitate evaluation of the discovery. An appropriate buffer area shall be established by the Qualified Paleontologist around the find where construction activities shall not be allowed to continue. Work shall be allowed to continue outside of the buffer area. All significant fossils shall be collected by the paleontological monitor and/or the Qualified Paleontologist. Collected fossils shall be prepared to the point of identification and catalogued before they are submitted to their final repository. Any fossils collected shall be curated at a public, non-profit institution with a research interest in the materials, such as the University of California Museum of Paleontology at Berkeley, if such an institution agrees to accept the fossils. If no institution accepts the fossil collection, they shall be donated to a local school in the area for educational purposes. Accompanying notes, maps, photographs, and a technical report shall also be filed at the repository and/or school.

Hydrology and Hydraulics

NEPA Mitigation Measures

Section 5.4.10 in the 2018 LSJR IIFR/EIS/EIR references no mitigation required. However, the general BMPs listed here would be implemented.

CEQA Mitigation Measures

Under CEQA, no mitigation is required.

Water Quality

NEPA Mitigation Measures

Section 5.5.10 in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

Avoidance and Minimization Measures (BMPs)

- The contractor would prepare a spill control plan and a SWPPP prior to initiation of construction in accordance with guidance from the RWQCB, Central Valley

Region. These plans would be reviewed and approved by USACE before construction begins.

- Implement appropriate measures to prevent debris, soil, rock or other material from entering the water. Use a water truck or other appropriate measures to control dust on haul roads, construction areas and stockpiles.
- Implement appropriate measures for handling and disposing of concrete and concrete washout water.
- Properly dispose of oil or other liquids.
- Fuel and maintain vehicles in a specified area that is designed to capture spills. This area cannot be near any ditch, stream or other body of water or feature that may convey water.
- Fuels and hazardous materials would not be stored on site.
- Inspect and maintain vehicles and equipment to prevent dripping oil and other fluids.
- Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, erosion control measures would be implemented as described in the RWQCB Erosion and Sediment Control Field Manual.
- Maintain sediment and erosion control measures during construction. Inspect the control measures before, during and after a rain event.
- Train construction workers in SWPPP and how to respond to, control, contain and clean up spills.
- Revegetate disturbed areas in a timely manner to control erosion.
- Materials will be covered and protected from wind, rain and runoff to avoid unwarranted dispersal.

In addition to the avoidance and minimization measures described above, design and operational criteria of the flood gates would be coordinated with RWQCB, NMFS, USFWS and CDFW to minimize potential water quality impacts. With mitigation and implementation of other CWA requirements, impacts associated with implementation of any of the alternatives (7a, 7b, 8a, 8b, 9a, 9b) would be less than significant.

CEQA Mitigation Measures

Mitigation Measure 3.2.6-1 from the 2023 TS30L Final SEIR shall apply in addition to all requirements of the SWPPP, BSSCP, and SPCCP.

Mitigation Measure 3.2.6-1 Water Quality Avoidance and Minimization Measures: The mitigation measures for Alternative 7a outlined in Section 5.5.10 of the 2018 LSJR FR/EIS/EIR shall be applied to the Modified Project in addition to all requirements of the SWPPP, BSSCP, and SPCCP:

- The contractor would prepare a spill control plan and a SWPPP prior to initiation of construction in accordance with guidance from the Regional Board, Central Valley Region. These plans would be reviewed and approved by USACE before construction begins.
- Implement appropriate measures to prevent debris, soil, rock, or other material from entering the water. Use vacuum sweepers or other appropriate measures to control dust on haul roads, construction areas and stockpiles.
- Implement appropriate measures for handling and disposing of concrete and concrete washout water.
- Properly dispose of oil or other liquids.
- Fuel and maintain vehicles in a specified area that is designed to capture spills. This area cannot be near any ditch, stream or other body of water or feature that may convey water.
- Fuels and hazardous materials would not be stored on site.
- Inspect and maintain vehicles and equipment to prevent dripping oil and other fluids.
- Schedule construction to avoid the rainy season as much as possible. If rains are forecasted during construction, erosion control measures would be implemented as described in the Regional Board Erosion and Sediment Control Field Manual.
- Maintain sediment and erosion control measures during construction. Inspect the control measures before, during and after a rain event.
- Train construction workers in SWPPP and how to respond to, control, contain and clean up spills.
- Revegetate disturbed areas in a timely manner to control erosion.
- Materials will be covered and protected from wind, rain and runoff to avoid unwarranted dispersal.
- Refine operational criteria to ensure that desired Flood Risk Management (FRM) benefits are achieved while avoiding degradation of water quality behind the closure structures.

Groundwater

NEPA Mitigation Measures

Section 5.3.5 in the 2018 LSJR IIFR/EIS/EIR references no mitigation that applies to the Proposed Action in the SEA. However, the general BMPs listed here and outlined in the SEA would be implemented.

CEQA Mitigation Measures

Under CEQA, no mitigation is required that applies to the Proposed Action in the SEA.

Wetlands and Other Waters of the United States

NEPA Mitigation Measures

Section 5.7.10 in the 2018 LSJR IIFR/EIS/EIR references the following.

Before construction, a qualified biologist would survey the project area and all wetlands and other waters of the U.S. would be subject to a formal jurisdictional determination and delineation to determine the extent and value of the wetlands affected. All delineated areas would be clearly marked and, to the extent feasible, avoided. Impacts would be minimized by establishing a buffer around wetlands and waterways. Construction worker awareness training would be conducted to ensure that personnel working the site know the location of and protocols for, working around sensitive habitat. Toe drains and local irrigation and drainage ditches would be relocated and restored with similar wetland habitat functions.

CEQA Mitigation Measures

Mitigation Measure 3.6-20 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.6-20 No Net Loss of Wetlands/Waters. SJAFCA shall conduct an aquatic resources delineation to identify potential wetlands and other waters that fall under state and federal jurisdiction within mitigation sites and borrow sites.

Temporary and permanent impacts on riparian habitat and wetland/waters that cannot be mitigated through avoidance, minimization, or remediation shall be mitigated to ensure no net loss through compensation, by restoring riparian and wetlands/waters habitat at one of the proposed biological mitigation sites or an approved off-site location, mitigation bank, or in-lieu fee program. Riparian and wetlands/waters habitat shall not be restored where it would be removed by future maintenance activities. A revegetation plan shall be prepared by a qualified biologist or landscape architect and reviewed by the appropriate agencies. The revegetation plan will specify the use of beneficial native plants appropriate for each area that provide a diverse variety of grasses and forbs that support native wildlife species.

Air Quality

NEPA Mitigation Measures

Section 5.8.10 in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

Alternative 7a Mitigation

The following measures focus on reducing NOx emissions. The Lead Agency shall either:

- Require the use of off-road equipment that meets or exceeds USEPA or California Air Resources Board CARB Tier 3 off-road emission standards for all off-road vehicles greater than 25 horsepower and operating for more than 20 total hours over the entire duration of construction activities. Prior to issuance of a construction permit, the prime contractor(s) shall prepare and submit a Construction Emissions Minimization Plan (Plan) to the Lead Agency for review and approval. The Plan shall include estimates of the construction timeline by phase with a description of each piece of equipment required for every construction phase. Equipment descriptions and information shall include: equipment type, equipment manufacturer, equipment identification number, engine model year, engine certification (Tier rating), horsepower, engine serial number and expected fuel usage and hours of operation. The Plan shall be kept by the Lead Agency and made available for review by any persons requesting it. Quarterly reports shall be submitted by the prime contractor(s) to the Lead Agency indicating the construction phase and equipment information used during each phase for the previous quarter;

<u>or</u>

- Enter into a Verified Emission Reduction Agreement (VERA) with SJVAPCD. The VERA would require payment of a fee to SJVAPCD that would be used to purchase NOx emission reductions to offset all NOx emissions during years when the Project's unmitigated NOx emissions exceed 10 tons. The VERA will be entered into prior to initiating the project and posted on the Lead Agency's website. The NOx offsets developed by the fee will be provided to the Lead Agency and posted on the Lead Agency's website. The information shall be posted in a location that is easy to access by the public and must remain on the website for 1 full year after all construction is completed. Implementation of either measure listed above will reduce NOx emissions during construction. The use of Tier 3 only vehicles also results in reductions of other criteria pollutants: ROG, CO, PM10 and PM2.5. However, those emission reductions are not shown in Table 5-10, because the unmitigated emissions of these other pollutants (Table 5-9) are below State and Federal significance thresholds.

CEQA Mitigation Measures

Mitigation Measure 3.2.2-1 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.2.2-1 Reduce Construction-Related NOX Emissions: The mitigation measure for Alternative 7a outlined in Section 5.8.10 of the 2018 LSJR IIFR/EIS/EIR shall be applied:

- USACE shall require the use of off-road equipment that meets or exceeds USEPA or California Air Resources Board CARB Tier 4 off-road emission standards for all off-road vehicles greater than 25 horsepower and operating for more than 20 total hours over the entire duration of construction activities. Prior to issuance of a construction permit, the prime contractor(s) shall prepare and submit a Construction Emissions Minimization Plan (Plan) to USACE for review and approval. The Plan shall include estimates of the construction timeline by phase with a description of each piece of equipment required for every construction phase. Equipment descriptions and information shall include: equipment type, equipment manufacturer, equipment identification number, engine model year, engine certification (Tier rating), horsepower, engine serial number and expected fuel usage and hours of operation. The Plan shall be kept by USACE and made available for review by any persons requesting it. Quarterly reports shall be submitted by the prime contractor(s) to USACE indicating the construction phase and equipment information used during each phase for the previous quarter.

Vegetation and Wildlife

NEPA Mitigation Measures

Sections 5.9.10 for Vegetation and 5.10.10 for Wildlife in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

Section 5.9.10 for Vegetation Mitigation

Mitigation includes avoidance, minimization, remediation and compensation.

Avoid and Minimize

During the design refinement phase, plans would be evaluated to reduce the impact on vegetation to the extent practicable. Refinements could include reduction in the project footprint. USACE will also seek a vegetation variance in order to comply with the Vegetation ETL. Receipt of a variance would allow vegetation to remain on the lower two thirds of the waterside levee slope and within the waterside easement. In addition, if a variance is granted, USACE will seek opportunities to plant vegetation on the waterside of the levees in order to compensate for impacts to SRA habitat in accordance with the terms and conditions of the NMFS BO. The avoidance and minimization measures identified would be used to mitigate potential impacts to vegetation outside of the project footprint.

Install Exclusion Fencing along the Construction Work Area Perimeter and Implement General Measures to Avoid Effects on Sensitive Natural Communities and Special-Status Species

To clearly demarcate the project boundary and protect sensitive natural communities, temporary exclusion fencing would be installed around the project boundaries (including access roads, staging areas, etc.) 1 week prior to the start of construction activities. The temporary fencing would be continuously maintained until all construction activities were completed so that construction equipment would be confined to the designated work areas, including any off-site mitigation areas and access thereto. The exclusion fencing would be removed only after construction for the year is entirely completed.

Exclusionary construction fencing and explanatory signage would be placed around the perimeter of sensitive vegetation communities that could be affected by construction activities throughout the period no effect on the community is allowed. Where feasible, the fencing would include a buffer zone of at least 20 feet between the resource and construction activities. All exclusionary fencing would be maintained in good condition throughout the construction period.

Conduct Mandatory Contractor/Worker Awareness Training for Construction Personnel

Before initiating any work in the project area, including grading, a qualified biologist would conduct mandatory contractor/worker awareness training for all construction personnel. It would be provided to brief them on the need to avoid effects on sensitive biological resources (e.g., riparian habitat, special-status species, wetlands and other sensitive biological communities) and the penalties for not complying with permit requirements. The biologist would inform all construction personnel about the life history of special status species with potential for occurrence on the site, the importance of maintaining habitat and the terms and conditions of the BO or other authorizing document. Proof of this instruction would be submitted to USFWS and CDFW.

The training would also cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on sensitive biological communities and special-status species during project construction. The crew leader would be responsible for ensuring that crew members adhere to the guidelines and restrictions. Educational training would be conducted for new personnel as they are brought on the job. General restrictions and guidelines for vegetation and wildlife that must be followed by construction personnel are listed.

- Project-related vehicles would observe the posted speed limit on hard-surfaced roads and a 10-mile-per-hour speed limit on unpaved roads during travel in the project site.
- Project-related vehicles and construction equipment would restrict off-road travel to the designated construction area.
- To prevent possible resource damage from hazardous materials such as motor oil or gasoline, construction personnel would not service vehicles or construction equipment outside designated staging areas.

Retain a Biological Monitor

A qualified biologist would monitor construction activities adjacent to sensitive biological resources (e.g., special-status species, riparian habitat, wetlands, elderberry shrubs), as needed. The biologists would assist the construction crew, as needed, to comply with all project implementation restrictions and guidelines. In addition, the biologist would be responsible for ensuring that construction barriers fencing is maintained adjacent to sensitive biological resources.

Remediation

After construction, structural FRM features and easement areas would be reseeded with native grasses and herbs and/or planted with appropriate herbaceous riparian and wetland species.

Compensation

Vegetation impacts that cannot be mitigated through avoidance, minimization or remediation will be mitigated through compensation. A 14 acre mitigation site has been identified at the setback area in the Delta Front portion of the study area. This site would be planted with primarily VELB compensation and associated riparian habitat. Additional compensation required for riparian, SRA, wetland and open water habitats would be accomplished through the purchase of credits at a mitigation bank. More information regarding proposed compensation can be found in the Habitat Mitigation, Monitoring and Adaptive Management Plan. Where possible, on-site mitigation areas would be the preferred action. USACE would seek opportunities to increase on site mitigation options during the design phase of the project, in accordance with the term and conditions of the NMFS BO. Mitigation site selection would avoid areas where future disturbance or maintenance is likely. A revegetation plan would be prepared by a qualified biologist or landscape architect and reviewed by the appropriate agencies. The revegetation plan would specify the planting stock appropriate for each riparian cover type and each mitigation site, ensuring the use of genetic stock from the project area and would employ the most successful techniques available at the time of planting. The plantings would be maintained and monitored, as necessary, for 3 to 5 years, including weed removal, irrigation and herbivory protection. USACE would submit annual monitoring reports of survival to the regulatory agencies including USFWS, NMFS and CDFW. Replanting would be necessary if success criteria are not met and replacement plants would subsequently be monitored and maintained to meet the success criteria. The mitigation would be considered successful when the plants meet the success criteria, the vegetation no longer requires active management and is arranged in groups that, when mature, replicate the area, natural structure and species composition of similar plant communities in the region.

Section 5.10.10 for Wildlife Mitigation

The same mitigation measures apply to all of the action alternatives, although the amount of compensatory mitigation would vary based upon the amount and quality of habitat temporarily and permanently affected by the project. Measures to avoid potential impacts to special status species are described in Section 5.12 in the 2018 LSJR IIFR/EIS/EIR and would also benefit more common wildlife. Mitigation described in Section 5.9 in the 2018 LSJR IIFR/EIS/EIR for vegetation would also avoid, minimize, rectify and/or compensate for potential impacts to wildlife.

CEQA Mitigation Measures

Mitigation Measures 3.6-16, 3.6-17, and 3.6-18 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.6-16 Temporary Fencing. To clearly demarcate the Modified Project's boundaries and protect sensitive natural communities, temporary exclusion fencing shall be installed around the Modified Project boundaries (e.g., access roads, staging areas) 1 week prior to the start of construction activities. The temporary fencing shall be continuously maintained until all construction activities are completed so that construction equipment is confined to the designated work areas, including any off-site mitigation areas and access thereto. The exclusion fencing shall be removed only after construction for the year is entirely completed. Exclusionary construction fencing and explanatory signage shall be placed around the perimeter of sensitive vegetation communities that could be affected by construction activities throughout the period during which such effects occur. The signage will explain the nature of the sensitive resource and warn that no effect on the community is allowed. Where feasible, the fencing will include a buffer zone of at least 20 feet between the resource an construction activities. All exclusionary fencing shall be maintained in good condition throughout the construction period.

Mitigation Measure 3.6-17 Mandatory Contractor/Worker Awareness Training. Before the initiation of any work in the Modified Project area, including grading, a qualified biologist shall conduct mandatory contractor/worker awareness training for all construction personnel. This training shall be provided to brief workers on the need to avoid effects on sensitive biological resources (e.g., riparian habitat, special-status species, wetlands, and other sensitive biological communities) and the penalties for not complying with permit requirements. The biologist shall inform all construction personnel about the life history of special-status species with potential for occurrence on the site, the importance of maintaining habitat, and the terms and conditions of the BO or other authorizing document. Proof of this instruction shall be submitted to USFWS.

The training shall also cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on sensitive biological communities and special-status species during Modified Project construction. The crew leader shall be responsible for ensuring that crew members adhere to the guidelines and restrictions. Educational training shall be conducted for new personnel as they are brought on the job. General restrictions and guidelines for vegetation and wildlife that must be followed by construction personnel are listed below.

- Modified Project–related vehicles shall observe the posted speed limit on hard-surfaced roads and a speed limit of 10 miles per hour on unpaved roads during travel on the project site.
- Modified Project–related vehicles and construction equipment shall restrict their off-road travel to the designated construction area.
- To prevent possible resource damage from hazardous materials such as motor oil or gasoline, construction personnel shall not service vehicles or construction equipment outside designated staging areas.

Mitigation Measure 3.6-18 Construction Monitoring. A qualified biologist shall monitor construction activities adjacent to sensitive biological resources (e.g., special-status species, riparian habitat, wetlands, elderberry shrubs), as needed. The biologist shall assist the construction crew, as needed, to comply with all Modified Project implementation restrictions and guidelines. In addition, the biologist shall be responsible for ensuring that construction barrier fencing is maintained adjacent to sensitive biological resources.

Special Status Species

NEPA Mitigation Measures

Section 5.12.10 in the 2018 LSJR IIFR/EIS/EIR references the following conservation and mitigation measures for special status wildlife, plants, and fish species and would be implemented.

Section 5.12.10.1 Special Status Wildlife Species

Valley Elderberry Longhorn Beetle

Avoidance and Minimization Measures – Construction Phase

The following is a summary of measures based on the *Conservation Guidelines for the Valley Elderberry Longhorn Beetle* (USFWS, 1999a). These measures would be implemented to minimize any potential effects on VELB or their habitat, including restoration and maintenance activities, long term, protection and compensation if shrubs cannot be avoided.

- When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) would be assumed.
- Where encroachment on the 100-foot buffer has been approved by USFWS, a setback of 20 feet from the dripline of each elderberry shrub would be maintained whenever possible.
- Shrubs that are closer than 100 feet to any work, but outside the construction footprint (construction, ETL compliance, OMRRR) are assumed to be avoided by the application of other avoidance measures such as signage, fencing, worker education and will not be subject to transplantation or the need for offset compensation.
- During construction activities, all areas to be avoided would be fenced and flagged.
- Contractors and work crews would be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.
- Signs would be erected every 50 feet along the edge of the avoidance area, identifying the area as an environmentally sensitive area.
- Any damage done to the buffer area would be restored.
- Buffer areas would continue to be protected after construction from adverse effects of the project, such as during maintenance actions.
- No insecticides, herbicides, fertilizers or other chemicals that might harm the beetle or its host plant would be used in the buffer areas.
- Trimming of elderberry plants may be subject to mitigation measures.
- Elderberry shrubs that cannot be avoided would be transplanted to an appropriate riparian area at least 100 feet from construction activities or to an approved conservation bank.
- If possible, elderberry shrubs would be transplanted during their dormant season (about November, after they have lost their leaves, through the first two weeks in February). If transplantation occurs during the growing season, increased mitigation ratios would apply.

- Any areas that receive transplanted elderberry shrubs and elderberry cuttings would be protected in perpetuity.
- USACE would develop off-site compensation areas prior to or concurrent with any take of VELB.
- USACE will submit its site suitability study to USFWS for review and comment prior to implementation; and request and receive written concurrence from USFWS that the site(s) is suitable for compensation for this project prior to construction.
- Management of these lands would include all measures specified in USFWS's conservation guidelines (1999a) related to weed and litter control, fencing and the placement of signs.
- Monitoring would occur for ten consecutive years or for seven non-consecutive years over a 15-year period. Annual monitoring reports would be submitted to USFWS.
- Off-site areas would be protected in perpetuity and have a funding source for maintenance.

Compensation Measures – Construction Phase

In accordance with the USFWS 1999 *Conservation Guidelines for the Valley Elderberry Longhorn Beetle,* adverse effects to the VELB would be compensated by transplanting the affected elderberries with stems greater than 1 inch in diameter and by planting a mix of native riparian/or upland vegetation at a 2:1 and 6:1 ratio depending on the diameter size of the stems. The amount of compensation for VELB was based on preliminary surveys conducted since the Draft EIS/EIR was released for review. VELB compensation is proposed to occur in the 14-acre mitigation site that has been identified at the setback levee on Fourteenmile slough. This site would be planted with transplanted shrubs and new seedlings and associated riparian habitat, in accordance with the USFWS guidelines.

Avoidance and Minimization Measures – O&M Phase

- When a 100-foot (or wider) buffer is established and maintained around elderberry shrubs, complete avoidance (i.e., no adverse effects) will be assumed.
- Where encroachment on the 100-foot buffer has been approved by the USFWS, a setback of 20 feet from the dripline of each elderberry shrub will be maintained whenever possible.
- During maintenance activities, all areas to be avoided will be fenced and flagged.
- Maintenance personnel will be briefed on the need to avoid damaging elderberry shrubs and the possible penalties for not complying with these requirements.

- Dust control measures shall be implemented when O&M activities take place within 100 feet of elderberry shrubs.

Compensation Measures – Operation and Maintenance Phase

If elderberry shrubs require trimming during O&M activities, the non-Federal maintaining agencies would plant 1 seedling elderberry and 2 native plants for every 10 existing elderberry shrubs trimmed during O&M. A USFWS approved off site area would be identified to receive the compensation plantings.

Giant Garter Snake

Avoidance and Minimization Measures – Construction Phase

The following measures would be implemented to minimize effects on GGS habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction would be initiated only during the GGS active period (May 1–October 1, when they are able to move away from disturbance).
- All construction personnel, including workers and contractors, will participate in a worker environmental awareness training program conducted by a USFWS-approved biologist prior to commencement of construction activities.
- A GGS survey would be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than two weeks, a biologist would survey the project area again no later than 24 hours prior to the restart of work.
- GGS encountered during construction activities would be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site would be restricted to established roadways. Stockpiling of construction materials would be restricted to designated staging areas, which would be located more than 200 feet away from GGS aquatic habitat.
- GGS habitat within 200 feet of construction activities would be designated as an environmentally sensitive area and delineated with signs and high visibility fencing. Fencing will be inspected and maintained as needed daily until completion of each work section of the project. This area would be avoided by all construction personnel.

- If USACE elects to use exclusionary fencing in lieu of continuous monitoring, it will be buried at least six inches below the ground to prevent snakes from burrowing and moving under the fence and will be inspected daily.
- If a frac-out is identified, all work will stop, including the recycling of the bentonite fluid. In the event of a frac-out into w6ater, the location and extent of the frac-out will be determined and the frac-out will be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- USFWS, NMFS, CDFW and the Regional Water Quality Control Board will be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be onsite and used if a frac-out occurs. Containment materials, such as straw bales, also will be onsite prior to and during all operations and a vacuum truck will be on retainer and available to be operational onsite within notice of 2 hours. The site supervisor will take any necessary follow-up response actions in coordination with agency representatives. The site supervisor will coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks) as needed.
- If the frac-out has reached the surface, any material contaminated with bentonite will be removed by hand to a depth of 1-foot, contained and properly disposed of, as required by law. The drilling contractor will be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- Project-related vehicles will observe a 20-mile-per-hour speed limit within construction areas, except on existing paved roads where they will adhere to the posted speed limits.
- Aquatic habitat for the snake that would be affected by construction will be inspected for the snake, then dewatered and maintained dry and absent of aquatic prey for 5 days before initiation of construction activities. This measure applies primarily to the ditches to be relocated west of the Delta front levee sections. If complete dewatering is not possible, USFWS will be contacted to determine what if any additional measures may be necessary to minimize effects to the snake.

<u>Compensation Measures – Construction Phase</u>

Compensation to off-set unavoidable effects on 12.5 acres of GGS upland habitat would be provided at a ratio of 1:1 through the purchase of credits at a mitigation bank. Compensation for permanent impacts to 0.5 acres of aquatic GGS habitat will be replaced at a 3:1 ratio through the purchase of credits at a mitigation bank.

If any GGS habitat is impacted by construction, the following measures would be implemented to compensate for the habitat loss:

- Habitat (including aquatic and upland) temporarily impacted for one season (May 1–October 1) will be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.
- Aquatic habitat permanently impacted will be replaced at a 3:1 ratio.
- Upland habitat permanently impacted will be replaced at a 1:1 ratio.
- Habitat permanently or temporarily impacted outside of the May 1-October 1 work window will be created at a 2:1 ratio.
- USACE will work to develop appropriate mitigation prior to or concurrent with any disturbance of GGS habitat. Habitat will be protected in perpetuity.

The following measures would be implemented during construction of the proposed Fourteenmile Slough and Smith Canal closure structures to reduce potential adverse effects on GGS and their habitats.

- Unless approved otherwise by USFWS, construction would be initiated only during the GGS' active period (May 1–October 1, when they are able to move away from disturbance).
- Install and maintain exclusion and construction barrier fencing around suitable GGS habitat.
- Prepare and implement a Stormwater Pollution Prevention Plan.
- Prepare and implement a Spill Prevention, Control and Counter-Measure Plan.
- Conduct preconstruction surveys and monitoring for GGS.
- Provide escape ramps to and cover open trenches at the end of each work day.
- Restore disturbed aquatic and upland habitat to pre-action conditions.

Avoidance and Minimization – O&M Phase

- O&M activities would occur between May 1 and October 1 during the snake's active season to minimize impacts to the species.
- O&M personnel will participate in USFWS-approved worker environmental awareness program.
- A GGS survey would be conducted 24 hours prior to O&M activities in potential habitat. Should there be any interruption in work for greater than two weeks; a biologist would survey the project area again no later than 24 hours prior to the restart of work.

- GGS encountered during O&M activities will be allowed to move away from on their own.
- Movement of heavy equipment to and from the site will be restricted to established roadways. Stockpiling of O&M materials will be restricted to designated staging areas, which will be located more than 200 feet away from GGS aquatic habitat.

Riparian Brush Rabbit

Compensation for effects to riparian brush rabbit habitat would consist of activities to: (1) create and restore natural habitats, (2) improve or enhance habitat quality and (3) protect and preserve in perpetuity habitat and open space. Compensation for impacts to riparian brush rabbit would be provided at a ratio of 3:1 and may include both waterside and landside riparian habitat restoration or enhancement and preservation at a USFWS-approved site, which could include one or both of the proposed habitat compensation areas described below. All potential riparian brush rabbit habitat that are affected by project implementation would be compensated accordingly.

If occupied habitat would be affected, an Incidental Take Permit will be required and a separate consultation with USFWS under the FESA and with DFG under California ESA shall be conducted. These actions shall be separate from the San Joaquin County Multi-Species Habitat Conservation and Open Space Plan (SJMSCP) and will require project-specific authorization and permitting. Specific mitigation measures shall be developed during the consultation process, including, but not limited to:

- Conducting preconstruction surveys;
- Conducting daily surveys of construction areas;
- Installing exclusion fencing to prevent brush rabbits from entering construction areas;
- Allowing trapping of riparian brush rabbits at the project site in support of the USFWS captive breeding program to establish new populations in appropriate habitat;
- Providing on site or off site compensatory mitigation for habitat loses.

These measures to minimize direct take in conjunction with compensation for adverse effects are anticipated to avoid a net reduction in the number of riparian brush rabbits. However, the potential loss of riparian brush rabbit population in the study area could restrict the range of this species because the RD 17 area currently contains the northernmost known extent of the population on the SJR.

Swainson's Hawk

To avoid and minimize effects to Swainson's hawk, USACE would implement the following BMP measures:

- Before ground disturbance, all construction personnel would participate in a CDFG-approved worker environmental awareness program. A qualified biologist would inform all construction personnel about the life history of Swainson's hawk and the importance of nest sites and foraging habitat.
- A breeding season survey for nesting birds would be conducted for all trees and shrubs that would be removed or disturbed which are located within 500 feet (0.5 miles for Swainson's hawk) of construction activities, including grading. Swainson's hawk surveys would be completed during at least 2 of the following survey periods: January 1 to March 20, March 20 to April 5, April 5 to April 20 and June 10 to July 30, with no fewer than 3 surveys completed in at least 2 survey periods and with at least 1 of these surveys occurring immediately prior to project initiation (Swainson's Hawk Technical Advisory Committee, 2000). Other migratory bird nest surveys could be conducted concurrent with Swainson's hawk surveys with at least 1 survey to be conducted no more than 48 hours from the initiation of project activities to confirm the absence of nesting. If the biologist determines that the area surveyed does not contain any active nests, construction activities, including removal or pruning of trees and shrubs, could commence without any further mitigation.
- If active nests are found, USACE would maintain a 0.25-mile buffer between construction activities and the active nest(s). In addition, a qualified biologist would be present on site during construction activities to ensure the buffer distance is adequate and the birds are not showing any signs of stress. If signs of stress that could cause nest abandonment are noted, construction activities would cease until a qualified biologist determines that fledglings have left an active nest.

Other migratory birds also have potential to nest in or adjacent to the study area and would be significantly affected by construction activities. The following BMPs would be implemented:

- Tree and shrub removal and other areas scheduled for vegetation clearing, grading or other construction activities would not be conducted during the nesting season (generally February 15 through August 31 depending on the species and environmental conditions for any given year). These construction activities could affect them by removing or causing abandonment of active nests of migratory birds protected under the Migratory Bird Treaty Act (MBTA) and CFGC. Implementation of minimization and avoidance measures described below would avoid, reduce or minimize the significant effect.

- To reduce the impact on Swainson's Hawk habitat, USACE will seek a vegetation variance to allow preservation of vegetation on the waterside levee slope and levee toe, and where bank protection work is performed, the sites would be planted with vegetation and trees that will provide habitat for the hawks.
- To compensate for the removal of acreage of riparian habitat supporting Swainson's hawks and other migratory birds, replacement habitat will be created as a mitigation area. For mitigation lands within the San Joaquin and Calaveras river systems, species selected to compensate for the riparian corridor removal will be consistent with the approved list of trees, shrubs and herbaceous plants native to the system. Additional mitigation may be planted in the expanded Mormon Channel Bypass (Old Mormon Slough) or on other lands within the Stockton area that provide similar value to those removed. Mitigation within the study area will prove to be contiguous and create habitat connectivity with wildlife migratory corridors that supports the needs of important native wildlife species without compromising the integrity of the flood control facilities. The exact location of the compensation lands in the study area would be coordinated in the design phase of the project with the sponsor and comply with the local SJMSCP objectives and goals. land, other locations within the Stockton area would be identified and public coordination would occur.

Special Status Bird Species

USACE would conduct surveys to locate nest sites of the mentioned species in suitable breeding habitats in the spring of each construction year. Surveys would be conducted by a qualified biologist using survey methods approved by USFWS. Survey results would be submitted to USFWS before construction is initiated. If nests or young of these species are not located, construction may proceed. If nests or young are located, USACE would consult with USFWS and CDFW to determine what mitigation measures could be implemented to avoid or reduce potential disturbance-related impacts to these species. Measures could include a no-disturbance buffer zone established around the nest site. The width of the buffer zone would be determined by a qualified biologist in coordination with USFWS. No construction activities would occur within the buffer zone, which would be maintained until the young have fledged (as determined by a qualified biologist).

Burrowing Owl

Prior to initiation of any excavation activities at borrow sites, a preconstruction survey for burrowing owls would be completed in accordance with CDFW guidelines described in the Staff Report on Burrowing Owl Mitigation. If no burrowing owls are located during these surveys, then effects to burrowing owls would be less than significant and no mitigation would be required. If burrowing owls are located on or immediately adjacent to the site, then coordination would occur with CDFW to determine the proper measures that would need to be implemented to ensure that burrowing owls are not impacted by the project. Potential mitigation measures that could be implemented include:

- A CDFW-qualified biologist shall conduct appropriate surveys at and around material source sites, to determine the presence/absence of burrowing owls. At least one survey shall be conducted no more than one week prior to the onset of any construction activity.
- A 250-foot buffer, within which no new activity would be permissible, would be maintained between project activities and nesting burrowing owls. This protected area would remain in effect until August 31 or at CDFW discretion, until the young owls are foraging independently.
- No burrowing owls could be evicted from burrows during the nesting season (February 1 through August 31). Eviction outside the nesting season could be permitted pending evaluation of eviction plans and receipt of formal written approval from CDFW authorizing the eviction.
- If accidental take (disturbance, injury or death of owls) occurs, the DFG would be notified immediately.
- Conduct mandatory worker awareness training for construction personnel.

Special Status Bat Species

The following measures would be implemented to reduce short term impacts to special status bat species from construction of the proposed alternatives:

- A qualified biologist would examine trees for suitable bat roosting habitat before removal or trimming. High quality features (large tree cavities, basal hollows, loose or peeling bark, larger snags, palm trees, with intact thatch, etc.) would be identified and the area around these features would be searched for bats and bat signs (guano, culled insect parts, staining, etc.). If suitable habitat and/or bat signs are detected, biologists would conduct evening visual emergence surveys from half an hour before sunset to 1 to 2 hours after sunset for a minimum of 2 nights. The survey shall be conducted no more than one week prior to the onset of any construction activity. If no bat roosts are located, no further mitigation is necessary.
- If active roosting western red bats are identified within the survey area, CDFW shall be immediately notified to determine what mitigation measures could be implemented to avoid or reduce potential disturbance-related impacts to these species.

Section 5.12.10.2 Special Status Plant Species

Before project construction, surveys for special-status plants in Table 5-35 shall be conducted by a qualified botanist at the appropriate time of year when the target species would be in flower or otherwise clearly identifiable. Surveys shall be conducted in accordance with specific guidelines described by Protocols for Surveying and Evaluating Impacts to Special Status Native Plant Populations and Natural Communities (CDFG, 2009).

If special-status plants are found, the following measures shall be implemented:

- Qualified botanists would survey the biological study area to document the presence of special status plants before project implementation and would conduct a floristic survey that follows the CDFW botanical survey guidelines (CDFG 2009). All plant species observed would be identified to the level necessary to determine whether they qualify as special-status plants or are plant species with unusual or significant range extensions. The guidelines also require that field surveys be conducted when special-status plants that could occur in the area are evident and identifiable, generally during the reported blooming period. To account for different special-status plant identification periods, one or more series of field surveys may be required in spring and summer. If any special-status plants are identified during the surveys, the botanist would photograph and map locations of the plants, document the location and extent of the special-status plant population on a CNDDB Survey Form and submit the completed Survey Form to the CNDDB. The amount of compensatory mitigation required would be based on the results of these surveys.

- If one or more special status plants is identified in the biological study area during preconstruction surveys, the sponsor would redesign or modify the proposed project components to avoid indirect or direct effects on special status plants wherever feasible. If special status plants cannot be avoided by redesigning projects, implementation of mitigation, (avoidance, and minimization, and compensatory) would avoid significant effects on special status plants.

- If complete avoidance of special status plants is not feasible, the effects of the project on special status plants would be compensated through off site preservation at a ratio to be negotiated with the resource agencies. Suitable habitat for affected special-status plant species would be purchased in a conservation area, preserved and managed in perpetuity. Detailed information would be provided to the agencies on the location and quality of the preservation area, the feasibility of protecting and managing the area in perpetuity and the responsible parties. Other pertinent information also would be provided, to be determined through future coordination with the resource agencies.

Section 5.12.10.3 Special Status Fish Species

See also the conservation measures and mitigation associated with SRA and riparian habitat addressed in VEGETATION (Section 5.9), WILDLIFE (Section 5.10) and the BMPs associated with construction related impacts such as dust, runoff and spills addressed in WATER QUALITY (Section 5.5).

Avoidance and Minimization Measures – Construction Phase

- Use BMPs to prevent slurry seeping out to river and require piping system on land side only.
- Stockpile construction materials such as portable equipment, vehicles and supplies at designated construction staging areas and barges, exclusive of any riparian and wetlands areas.
- Stockpile all liquid chemicals and supplies at a designated impermeable membrane fuel and refueling station with a 110 percent containment system.
- Implement erosion control measures (BMPs) including Stormwater Pollution Prevention Program and Water Pollution Control Program that minimize soil or sediment from entering the river. Install, monitor and maintain BMPs for effectiveness throughout construction operations to minimize effects to Federally listed fish and their designated critical habitat.
- Schedule construction when listed terrestrial and aquatic species would be least likely to occur in the project area. If construction needs to extend into the timeframe that species are present, coordinate with the resource agencies.
- Limit site access to the smallest area possible in order to minimize disturbance.
- Remove litter, debris, unused materials, equipment and supplies from the project area daily. Deposit such materials or waste at an appropriate disposal or storage site.
- Immediately (within 24 hours) clean up and report any spills of hazardous materials to the resource agencies. Report any such spills and the success of the efforts to clean them up, in post-construction compliance reports.
- Designate a USACE-appointed representative as the point-of-contact for any contractor who might incidentally take a living or find a dead, injured or entrapped, threatened or endangered species. Identify this representative to the employees and contractors during an all employee education program conducted by USACE.
- Screen any water pump intakes, as specified by NMFS and USFWS screening specifications. Water pumps will maintain flows to keep approach velocity at the pump screens at 0.2 feet per second or less when working in areas that may support delta smelt or juvenile salmonids.

The following measures would be implemented during construction of the proposed Fourteenmile Slough and Smith Canal closure structures to reduce potential adverse effects on ESA listed species, other native fish species and their habitats.

- All in-water construction activities would be limited to the period of June 1 through October 31 to avoid the primary migration periods of listed salmonids.
- In-water pile driving would be restricted to July 1 through September 30 to avoid or minimize exposure of adults and juvenile salmonids to underwater pile-driving sounds.
- All pile driving would be conducted by a vibratory pile driver to minimize underwater sound levels during pile-driving operations.
- Pile driving would be conducted by barge to minimize disturbance of riparian habitat.
- Conduct underwater noise monitoring during in-water construction to validate established noise thresholds are not exceeded (agreement with CDFG, USFWS, and NMFS).

Additional Minimization and Conservation Measures

To further avoid and minimize project effects on listed species and their critical habitat USACE would pursue the following additional measures during Preconstruction Engineering and Design (PED) and prior to construction:

- Where suitable, pursue a vegetation variance that would allow woody vegetation to remain on the lower waterside portion of the levee and within the 15’ waterside vegetation-free zone (where removal is not otherwise required for construction of the levee improvements, floodwall or closure structures).
- USACE will seek opportunities during the design phase of the project to establish SRA compensatory mitigation if a vegetation variance is approved.
- Minimize vegetation removal to the extent feasible.
- Minimize, to the extent possible, grubbing and contouring activities.
- Identify all habitats containing or with a substantial possibility of containing, listed terrestrial, wetland and plant species in the potentially affected project areas. To the extent practicable, efforts will be made to minimize effects by modifying engineering design to avoid potential direct and indirect effects.
- Incorporate sensitive habitat information into project bid specifications.
- Incorporate requirements for contractors to avoid identified sensitive habitats into project bid specifications.

CEQA Mitigation Measures

Mitigation Measures 3.6-1 through 3.6-18 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measures

Special-Status Plants

Mitigation Measure 3.6-1 Special-Status Plant Surveys. Before Modified Project construction, surveys for special-status plants with potential to occur shall be conducted by a qualified botanist at the appropriate time of year when the target species would be in flower or otherwise clearly identifiable. Surveys shall be conducted in accordance with specific guidelines described by Protocols for Surveying and Evaluating Impacts to Special-Status Native Plant Populations and Natural Communities (CDFW 2018).

Mitigation Measure 3.6-2 Special-Status Plant Measures. If special-status plants are found, the following measures shall be implemented:

- Qualified botanists shall survey the biological study area to document the presence of special-status plants before Modified Project implementation and shall conduct a floristic survey that follows the CDFW botanical survey guidelines (CDFW 2018). All plant species observed will be identified to the level necessary to determine whether they qualify as special-status plants or are plant species with unusual or significant range extensions. The guidelines also require that field surveys be conducted when special-status plants that could occur in the area are evident and identifiable, generally during the reported blooming period. To account for different special-status plant identification periods, one or more series of field surveys may be required in spring and summer. If any special-status plants are identified during the surveys, the botanist shall photograph and map locations of the plants, document the location and extent of the special-status plant population on a CNDDB survey form, and submit the completed survey form to the CNDDB. The amount of compensatory mitigation required will be based on the results of these surveys.

- If one or more special-status plants is identified in the biological study area during preconstruction surveys, the sponsor shall redesign or modify the Modified Project, including the restoration plans for the biological mitigation site components, to avoid indirect or direct effects on special-status plants wherever feasible. If special-status plants cannot be avoided by redesigning projects, compensatory mitigation shall be implemented to avoid significant effects on special-status plants.

- If complete avoidance of special-status plants is not feasible, the effects of the Modified Project on special-status plants shall be mitigated through off-site preservation at the chosen biological mitigation site at a minimum of a 1:1 ratio but shall be negotiated with the resource agencies. Suitable habitat for affected special-status plant species will occur in a conservation area, preserved and managed in perpetuity. Detailed information shall be provided to the agencies on the location and quality of the preservation area, the feasibility of protecting and managing the area in perpetuity, and the responsible parties. Other pertinent information also shall be provided, to be determined through future coordination with the resource agencies.

Swainson's Hawk

Mitigation Measure 3.6-3 Worker Awareness Training. Before ground disturbance, all construction personnel shall participate in a CDFW-approved worker environmental awareness program. A qualified biologist shall inform all construction personnel about the life history of Swainson's hawk and the importance of nest sites and foraging habitat.

Mitigation Measure 3.6-4 Breeding-Season Survey. If construction work is to occur during the Swainson's hawk breeding season, a breeding-season survey for nesting birds shall be conducted for all trees and shrubs that would be removed or disturbed that are located within 500 feet (0.5 mile for Swainson's hawk) of construction activities, including grading. Swainson's hawk surveys shall be completed during at least two of the following survey periods: January 1 to March 20; March 20 to April 5; April 5 to April 20; and June 10 to July 30. No fewer than three surveys shall be completed in at least two survey periods and at least one of these surveys shall occur immediately prior to Modified Project initiation (SWHA TAC 2000). Other migratory bird nest surveys could be conducted concurrent with Swainson's hawk surveys, with at least one survey to be conducted no more than 48 hours from the initiation of Modified Project activities to confirm the absence of nesting. If the biologist determines that the area surveyed does not contain any active nests, construction activities, including removal or pruning of trees and shrubs, could commence without any further mitigation.

Mitigation Measure 3.6-5 Active Nest Buffer. If active nests are found, USACE shall maintain a 0.25-mile buffer between construction activities and the active nest(s). In addition, a qualified biologist shall be present on-site during construction activities to ensure that the buffer distance is adequate and that the birds are not showing any signs of stress. If signs of stress that could cause nest abandonment are noted, construction activities shall cease until a qualified biologist determines that fledglings have left an active nest. With the written permission of the wildlife agencies and under the supervision of the qualified biologist, work within the temporary nest disturbance buffer may occur. The qualified biologist shall be on-site daily while construction-related activities are taking place within the buffer.

Burrowing Owl

Mitigation Measure 3.6-6 Burrowing Owl Preconstruction Surveys. Prior to initiation of any excavation activities at borrow sites, a preconstruction survey for burrowing owls shall be completed in accordance with CDFW guidelines described in the Staff Report on Burrowing Owl Mitigation. If no burrowing owls are located during these surveys, then effects on burrowing owls would be less than significant and no mitigation is required. If burrowing owls are located on or immediately adjacent to the site, then coordination shall occur with CDFW to determine the measures that need to be implemented to ensure that burrowing owls are not affected by the Modified Project. Potential mitigation measures that could be implemented include:

- A qualified biologist shall conduct appropriate surveys at and around material source sites, to determine the presence/absence of burrowing owls. At least one survey shall be conducted no more than 1 week prior to the onset of any construction activity.
- A 250-foot buffer, within which no new activity would be permissible, shall be maintained between Modified Project activities and nesting burrowing owls. This protected area shall remain in effect until August 31 or at CDFW's discretion, until the young owls are foraging independently.
- No burrowing owls shall be evicted from burrows during the nesting season (February 1 through August 31). Eviction outside the nesting season could be permitted pending evaluation of eviction plans and receipt of formal written approval from CDFW authorizing the eviction.
- Mandatory worker awareness training for construction personnel shall be conducted.

<u>Other Birds Listed by the Migratory Bird Treaty Act and the California Fish and Game Code</u>

Mitigation Measure 3.6-7 Nesting Bird Surveys. USACE shall conduct surveys in the spring of each construction year to locate nest sites of the mentioned species in suitable breeding habitats. Surveys shall be conducted by a qualified biologist using survey methods approved by USFWS. Survey results shall be submitted to USFWS before construction is initiated. If nests or young of these species are not located, construction may proceed. If nests or young are located, USACE shall coordinate with USFWS and CDFW to determine what mitigation measures could be implemented to avoid or reduce potential disturbance-related impacts on these species. Measures could include a no-disturbance buffer zone established around the nest site. The width of the buffer zone shall be determined by a qualified biologist in coordination with USFWS. No construction activities shall occur within the buffer zone, which shall be maintained until the young have fledged (as determined by a qualified biologist).

<u>Giant Garter Snake</u>

Mitigation Measure 3.6-8 Minimization of Effects on Giant Garter Snake. The following measures shall be implemented to minimize effects on giant garter snake habitat that occurs within 200 feet of any construction activity. These measures are based on USFWS guidelines for restoration and standard avoidance measures included as appendices in USFWS (1997).

- Unless approved otherwise by USFWS, construction shall be initiated only during the giant garter snake active period (May 1–October 1, when they are able to move away from disturbance).
- All construction personnel, including workers and contractors, shall participate in a worker environmental awareness training program conducted by a USFWS-approved biologist prior to commencement of construction activities.
- A giant garter snake survey shall be conducted 24 hours prior to construction in potential habitat. Should there be any interruption in work for greater than 2 weeks, a biologist shall survey the Modified Project area again no later than 24 hours prior to the restart of work.
- Giant garter snakes encountered during construction activities shall be allowed to move away from construction activities on their own.
- Movement of heavy equipment to and from the construction site shall be restricted to established roadways.
- Giant garter snake habitat within 200 feet of construction activities shall be designated as an environmentally sensitive area and delineated with signs and high-visibility fencing. Fencing shall be inspected and maintained as needed daily until completion of each work section of the Modified Project. This area shall be avoided by all construction personnel.
- If USACE elects to use exclusionary fencing in lieu of continuous monitoring, it shall be buried at least 6 inches below the ground to prevent snakes from burrowing and moving under the fence and shall be inspected daily.
- If a frac-out is identified, all work shall stop, including the recycling of the bentonite fluid. In the event of a frac-out into water, the location and extent of the frac-out shall be determined and the frac-out shall be monitored for 4 hours to determine whether the fluid congeals (bentonite will usually harden, effectively sealing the frac-out location).
- USFWS, NMFS, CDFW, and the Regional Water Quality Control Board shall be notified immediately of any spills and will be consulted regarding clean-up procedures. A Brady barrel will be on-site and shall be used if a frac-out occurs. Containment materials, such as straw bales, also will be on-site prior to and during all operations and a vacuum truck will be on retainer and available to be operational on-site within 2 hours' notice. The site supervisor shall take any necessary follow-up response actions in coordination with agency

representatives. The site supervisor shall coordinate the mobilization of equipment stored at staging areas (e.g., vacuum trucks) as needed.

- If the frac-out has reached the surface, any material contaminated with bentonite shall be removed by hand to a depth of 1 foot, contained, and properly disposed of, as required by law. The drilling contractor shall be responsible for ensuring that the bentonite is either properly disposed of at an approved Class II disposal facility or properly recycled in an approved manner.
- Project-related vehicles shall observe a 10 mph speed limit within construction areas, except on existing paved roads where they shall adhere to the posted speed limits.
- Aquatic habitat for the snake that would be affected by construction shall be inspected for the snake, then dewatered and maintained dry and absent of aquatic prey for 5 days before initiation of construction activities. This measure applies primarily to the ditches to be relocated west of the Delta front levee sections. If complete dewatering is not possible, USFWS shall be contacted to determine what additional measures, if any, may be necessary to minimize effects on the snake.

Mitigation Measure 3.6-9 Giant Garter Snake Compensation. If giant garter snake habitat would be temporarily affected during construction, the following measures shall be implemented to compensate for the habitat loss at the selected biological mitigation site:

- Habitat (including aquatic and upland) temporarily affected for one construction season (May 1–October 1) shall be restored after construction by applying appropriate erosion control techniques and replanting/seeding with appropriate native plants.
- Aquatic habitat permanently affected shall be replaced at a 3:1 ratio through the purchase of credits at a mitigation bank or the establishment of aquatic habitat at one of the mitigation sites.
- Upland habitat permanently affected shall be replaced at a minimum of 1:1 ratio.
- USACE shall work to develop appropriate mitigation prior to or concurrent with any disturbance of giant garter snake habitat. Habitat shall be protected in perpetuity and have an endowment attached for management and maintenance.

<u>Western Pond Turtle</u>

Implementation of Mitigation Measure 3.6-8, developed for giant garter snake, applies to western pond turtle and would reduce potential impacts on this species to a less-than-significant level.

Valley Elderberry Longhorn Beetle

Mitigation Measure 3.6-10 Minimization of Any Potential Effects on VELB or Their Habitat. During construction for the Modified Project, USACE shall implement the measures included in the *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle* (USFWS 2017b; see Appendix G) to reduce effects on valley elderberry longhorn beetle. The framework includes avoidance and minimization measures for shrubs that would not be transplanted within 50 meters of the Project, methodologies for transplanting of shrubs, and methodologies for compensatory mitigation guidance for removed habitat.

Mitigation Measure 3.6-11 VELB Compensation. In accordance with the USFWS 2017 *Framework for Assessing Impacts to the Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*),* adverse effects on the VELB shall be compensated for by transplanting the affected elderberries with stems greater than 1 inch in diameter and by planting a mix of native suitable riparian vegetation at a 3:1 ratio. The amount of compensation for VELB shall be based on USFWS review. A suitable transplant site shall be selected and planted with transplanted shrubs and new seedlings and associated riparian habitat, in accordance with the USFWS guidelines.

Special-Status Bats

The following measures would be implemented to reduce short-term impacts on special-status bat species from construction of the Modified Project.

Mitigation Measure 3.6-12 Bat and Roosting Habitat Survey. In advance of tree removal, a preconstruction survey for special-status bats shall be conducted by a qualified biologist to characterize potential bat habitat and identify active roost sites within the Modified Project site. Should potential roosting habitat or active bat roosts be found in trees and/or structures to be removed under the Modified Project, the following measures shall be implemented:

- Removal of trees and structures shall occur when bats are active, approximately March 1–April 15 and August 15–October 15, and outside of bat maternity roosting season (approximately April 15–August 31) and months of winter torpor (approximately October 15–February 28), to the extent feasible.
- If removal of trees during the periods when bats are active is not feasible and active bat roosts being used for maternity or hibernation purposes are found on or in the immediate vicinity of the Modified Project where tree removal is planned, a no-disturbance buffer of 100 feet shall be established around these roost sites until they are determined to be no longer active by the qualified biologist.
- The qualified biologist shall be present during tree removal if active bat roosts that are not being used for maternity or hibernation purposes are present. Trees with active roosts shall be removed only when no rain is occurring or is forecast

to occur for 3 days and when daytime temperatures are at least 50 degrees Fahrenheit.

- Removal of trees with active or potentially active roost sites shall follow a two-step removal process:
    - On the first day of tree removal and under supervision of the qualified biologist, branches and limbs not containing cavities or fissures in which bats could roost, shall be cut only using chain saws.
    - On the following day and under the supervision of the qualified biologist, the remainder of the tree may be removed, using either chain saws or other equipment (e.g., excavator or backhoe).
- Removal of structures containing or suspected to contain active bat roosts, that are not being used for maternity or hibernation purposes, shall be dismantled under the supervision of the qualified biologist in the evening and after bats have emerged from the roost to forage. Structures shall be partially dismantled to significantly change the roost conditions, causing bats to abandon and not return to the roost. If deemed necessary by a qualified biologist, bat exclusion devises may be installed to prevent the re-entry of bats to a roost.

<u>Special-Status Fish</u>

Mitigation Measure 3.6-13 Hazardous Materials Spill Notification. Given the deleterious effects of numerous chemicals on native resident fish used in construction, if a hazardous materials spill does occur, a detailed analysis shall be performed immediately by a registered environmental assessor or professional engineer to identify the likely cause and extent of contamination. This analysis shall conform to American Society for Testing and Materials standards and shall include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, USACE and its contractors shall select and implement measures to control contamination, with a performance standard that surface water and groundwater quality must be returned to baseline conditions.

Mitigation Measure 3.6-14 In-Water Work Windows. In-water construction for the biological mitigation sites shall be restricted to the general estimated work window required for each waterway as described in the NMFS 2016 BO or superseding BO. During preconstruction engineering and design, the work window may be adjusted on a site-specific basis, considering periods of low fish abundance, and in-water construction outside the principal spawning and migration season. The typical construction season generally corresponds to the dry season, but construction may occur outside the limits of the dry season, only as allowed by applicable permit conditions.

Mitigation Measure 3.6-15 Avoidance and Minimization of Effects on Listed Fish Species. In 2016, NMFS issued a BO for the LSJR Feasibility Study consultation for levee improvements. The NMFS BO evaluated impacts on Central Valley spring-run Chinook salmon, California Central Valley steelhead, and green sturgeon, as well as their critical habitat. The BO evaluated potential impacts based on rough estimates and preliminary designs for the proposed Project. To avoid and minimize effects on listed fish species, the measures from the 2016 NMFS BO or superseding BO shall be implemented.

Mitigation Measure 3.6-16 Temporary Fencing. To clearly demarcate the Modified Project's boundaries and protect sensitive natural communities, temporary exclusion fencing shall be installed around the Modified Project boundaries (e.g., access roads, staging areas) 1 week prior to the start of construction activities. The temporary fencing shall be continuously maintained until all construction activities are completed so that construction equipment is confined to the designated work areas, including any off-site mitigation areas and access thereto. The exclusion fencing shall be removed only after construction for the year is entirely completed. Exclusionary construction fencing and explanatory signage shall be placed around the perimeter of sensitive vegetation communities that could be affected by construction activities throughout the period during which such effects occur. The signage will explain the nature of the sensitive resource and warn that no effect on the community is allowed. Where feasible, the fencing will include a buffer zone of at least 20 feet between the resource and construction activities. All exclusionary fencing shall be maintained in good condition throughout the construction period.

Mitigation Measure 3.6-17 Mandatory Contractor/Worker Awareness Training. Before the initiation of any work in the Modified Project area, including grading, a qualified biologist shall conduct mandatory contractor/worker awareness training for all construction personnel. This training shall be provided to brief workers on the need to avoid effects on sensitive biological resources (e.g., riparian habitat, special-status species, wetlands, and other sensitive biological communities) and the penalties for not complying with permit requirements. The biologist shall inform all construction personnel about the life history of special-status species with potential for occurrence on the site, the importance of maintaining habitat, and the terms and conditions of the BO or other authorizing document. Proof of this instruction shall be submitted to USFWS.

The training shall also cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on sensitive biological communities and special-status species during Modified Project construction. The crew leader shall be responsible for ensuring that crew members adhere to the guidelines and restrictions. Educational training shall be conducted for new personnel as they are brought on the job. General restrictions and guidelines for vegetation and wildlife that must be followed by construction personnel are listed below.

- Modified Project–related vehicles shall observe the posted speed limit on hard-surfaced roads and a speed limit of 10 miles per hour on unpaved roads during travel on the project site.
- Modified Project–related vehicles and construction equipment shall restrict their off-road travel to the designated construction area.
- To prevent possible resource damage from hazardous materials such as motor oil or gasoline, construction personnel shall not service vehicles or construction equipment outside designated staging areas.

Mitigation Measure 3.6-18 Construction Monitoring. A qualified biologist shall monitor construction activities adjacent to sensitive biological resources (e.g., special-status species, riparian habitat, wetlands, elderberry shrubs), as needed. The biologist shall assist the construction crew, as needed, to comply with all Modified Project implementation restrictions and guidelines. In addition, the biologist shall be responsible for ensuring that construction barrier fencing is maintained adjacent to sensitive biological resources.

Socioeconomics

NEPA Mitigation Measures

Section 5.13.6 in the 2018 LSJR IIFR/EIS/EIR references no mitigation that applies to the Proposed Action in the SEA. However, the general BMPs listed here and outlined in the SEA would be implemented.

CEQA Mitigation Measures

Under CEQA, no mitigation is required.

Land Use

NEPA Mitigation Measures

Section 5.14.9 in the 2018 LSJR IIFR/EIS/EIR references no mitigation that applies to the Proposed Action in the SEA. However, the general BMPs listed here and outlined in the SEA would be implemented.

CEQA Mitigation Measures

Under CEQA, no mitigation is required.

Utilities and Public Services

NEPA Mitigation Measures

Section 5.16.10 in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

Mitigation would be the same for all the action alternatives. Before beginning construction, coordination with utility providers to implement orderly relocation of utilities that need to be removed or relocated would occur. Coordination would include the following:

- Notification of any potential interruptions in service shall be provided to the appropriate agencies and affected landowners.
- Before the start of construction, utility locations shall be verified through field surveys and the use of Underground Service Alert services. Any buried utility lines shall be clearly marked where construction activities would take place and on the construction specifications before of any earthmoving activities begin.
- Before the start of construction, the contractor would be required to coordinate with the local municipality and acquire any applicable permits prior to use of municipal water for construction.
- Before the start of construction, a response plan shall be prepared to address potential accidental damage to a utility line. The plan shall identify chain of command rules for notification of authorities and appropriate actions and responsibilities to ensure the public and worker safety. Worker education training in response to such situations shall be conducted by the contractor. The response plan shall be implemented by the contractor during construction activities.
- Utility relocations shall be staged to minimize interruptions in service.

CEQA Mitigation Measures

Mitigation Measures 3.2.8-1 and 3.11-1 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.2.8-1 Coordination with Utility Providers & Response Plan: The mitigation measures for Alternative 7a outlined in Section 5.16.10 of the 2018 LSJR FR/EIS/EIR shall be applied to the Modified Project:

- Before beginning construction, coordination with utility providers to implement orderly relocation of utilities that need to be removed or relocated would occur. Coordination would include the following:

- Notification of any potential interruptions in service shall be provided to the appropriate agencies and affected landowners.
- Before the start of construction, utility locations shall be verified through field surveys and the use of Underground Service Alert services. Any buried utility lines shall be clearly marked where construction activities would take place and on the construction specifications before of any earthmoving activities begin.
- Before the start of construction, the contractor would be required to coordinate with the local municipality and acquire any applicable permits prior to use of municipal water for construction.
- Before the start of construction, a response plan shall be prepared to address potential accidental damage to a utility line. The plan shall identify chain of command rules for notification of authorities and appropriate actions and responsibilities to ensure the public and worker safety. Worker education training in response to such situations shall be conducted by the contractor. The response plan shall be implemented by the contractor during construction activities.
- Utility relocations shall be staged to minimize interruptions in service.

Aesthetic Resources

NEPA Mitigation Measures

Section 5.18.10 in the 2018 LSJR IIFR/EIS/EIR references no mitigation that applies to the Proposed Action in the SEA. However, the general BMPs listed here and outlined in the SEA would be implemented.

CEQA Mitigation Measures

Mitigation Measures 3.6-16 through 3.6-19 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.6-16 Temporary Fencing. To clearly demarcate the Modified Project's boundaries and protect sensitive natural communities, temporary exclusion fencing shall be installed around the Modified Project boundaries (e.g., access roads, staging areas) 1 week prior to the start of construction activities. The temporary fencing shall be continuously maintained until all construction activities are completed so that construction equipment is confined to the designated work areas, including any off-site mitigation areas and access thereto. The exclusion fencing shall be removed only after construction for the year is entirely completed. Exclusionary construction fencing and explanatory signage shall be placed around the perimeter of sensitive vegetation communities that could be affected by construction activities throughout the period during which such effects occur. The signage will explain the nature of the sensitive resource and warn that no effect on the community is allowed. Where feasible, the fencing will include a buffer zone of at least 20 feet between the resource and construction activities. All exclusionary fencing shall be maintained in good condition throughout the construction period.

Mitigation Measure 3.6-17 Mandatory Contractor/Worker Awareness Training. Before the initiation of any work in the Modified Project area, including grading, a qualified biologist shall conduct mandatory contractor/worker awareness training for all construction personnel. This training shall be provided to brief workers on the need to avoid effects on sensitive biological resources (e.g., riparian habitat, special-status species, wetlands, and other sensitive biological communities) and the penalties for not complying with permit requirements. The biologist shall inform all construction personnel about the life history of special-status species with potential for occurrence on the site, the importance of maintaining habitat, and the terms and conditions of the BO or other authorizing document. Proof of this instruction shall be submitted to USFWS.

The training shall also cover the restrictions and guidelines that must be followed by all construction personnel to reduce or avoid effects on sensitive biological communities and special-status species during Modified Project construction. The crew leader shall be responsible for ensuring that crew members adhere to the guidelines and restrictions. Educational training shall be conducted for new personnel as they are brought on the job. General restrictions and guidelines for vegetation and wildlife that must be followed by construction personnel are listed below.

- Modified Project–related vehicles shall observe the posted speed limit on hard-surfaced roads and a speed limit of 10 miles per hour on unpaved roads during travel on the project site.
- Modified Project–related vehicles and construction equipment shall restrict their off-road travel to the designated construction area.
- To prevent possible resource damage from hazardous materials such as motor oil or gasoline, construction personnel shall not service vehicles or construction equipment outside designated staging areas.

Mitigation Measure 3.6-18 Construction Monitoring. A qualified biologist shall monitor construction activities adjacent to sensitive biological resources (e.g., special-status species, riparian habitat, wetlands, elderberry shrubs), as needed. The biologist shall assist the construction crew, as needed, to comply with all Modified Project implementation restrictions and guidelines. In addition, the biologist shall be responsible for ensuring that construction barrier fencing is maintained adjacent to sensitive biological resources.

Mitigation Measure 3.6-19 Riparian Compensation. Vegetation impacts that cannot be mitigated through avoidance, minimization, or remediation shall be mitigated through restoration at the selected biological mitigation site. A revegetation plan for the biological mitigation site shall be prepared by a qualified biologist or landscape architect and reviewed by the appropriate agencies. The revegetation plan shall specify the planting stock appropriate for each riparian cover type and each mitigation site, ensuring the use of genetic stock from the Modified Project area, and shall employ the most successful techniques available at the time of planting. The plantings shall be maintained and monitored as necessary for 3–5 years, including weed removal, irrigation, and herbivory protection. For this establishment period, USACE shall submit annual monitoring reports of survival to the regulatory agencies including USFWS, NMFS, and CDFW. Replanting will be necessary if success criteria are not met, with replacement plants subsequently monitored and maintained to meet the success criteria. The mitigation will be considered successful when the plants meet the success criteria and the vegetation no longer requires active management and is arranged in groups that, when mature, replicate the area, natural structure, and species composition of similar plant communities in the region.

If mitigation at the selected biological mitigation site is inadequate to fully compensate for the vegetation impacts, the remaining balance of compensation required for riparian, shaded riverine aquatic, wetland, and open water habitats shall be accomplished through the purchase of credits at a mitigation bank or the construction of additional mitigation sites. If an alternative biological mitigation site not evaluated in this SEIR is chosen for development, additional environmental review under CEQA will be required prior to construction.

Public Health and Environmental Hazards

NEPA Mitigation Measures

Section 5.20.10 in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

The following measures would be implemented before ground-disturbing or demolition activities begin, in order to reduce health hazards associated with potential exposure to hazardous substances:

- Complete a Phase I Site Assessment prior to completing preconstruction designs and initiating construction.
- Prepare a site plan that identifies any necessary remediation activities appropriate for proposed land uses, including excavation and removal of contaminated soils and redistribution of clean fill material on the project site. The plan would include measures that ensure the safe transport, use and disposal of contaminated soil and building debris removed from the site, as well as any other hazardous materials. In the event that contaminated groundwater is encountered during site excavation activities, the contractor would report the contamination to the appropriate regulatory agencies, dewater the excavated area and treat the

contaminated groundwater to remove contaminants before discharge into the sanitary sewer system. The contractor would be required to comply with the plan and applicable Federal, State and local laws.

- Notify appropriate Federal, State and local agencies if evidence of previously undiscovered soil or groundwater contamination is encountered during construction. Any contaminated areas would be cleaned up in accordance with the recommendations of the Central Valley RWQCB, California DTSC or other appropriate Federal, State or local regulatory agencies.
- A worker health and safety plan would be prepared before the start of construction that identifies, at a minimum, all contaminants that could be encountered during construction; all appropriate worker, public health and environmental protection equipment and procedures to be used during project activities; emergency response procedures; the most direct route to the nearest hospitals; and a Site Safety Officer. The plan would describe actions to be taken if hazardous materials are encountered on-site, including protocols for handling hazardous materials, preventing their spread and emergency procedures to be taken in the event of a spill.
- Retain licensed contractors to remove all underground storage tanks.

CEQA Mitigation Measures

Mitigation Measure 3.2.4-1 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.2.4-1 Reduce Hazards Associated with Potential Exposure to Hazardous Substances: The mitigation measures for Alternative 7a outlined in Section 5.20.10 of the 2018 LSJR FR/EIS/EIR have been slightly modified and shall be applied to the Modified Project:

- The following measures would be implemented before ground-disturbing or demolition activities begin, in order to reduce health hazards associated with potential exposure to hazardous substances:
    - Complete a Phase I Environmental Site Assessment (ESA) prior to completing preconstruction designs and initiating construction. Where construction activities would occur in close proximity to sites identified as Recognized Environmental Conditions in the Phase I ESA, a Phase II site investigation will also be conducted.
    - Prepare a site plan that identifies any necessary remediation activities appropriate for proposed land uses, including excavation and removal of contaminated soils and redistribution of clean fill material on the project site. The plan would include measures that ensure the safe transport, use and disposal of contaminated soil and building debris removed from the

site, as well as any other hazardous materials. In the event that contaminated groundwater is encountered during site excavation activities, the contractor would report the contamination to the appropriate regulatory agencies, dewater the excavated area and treat the contaminated groundwater to remove contaminants before discharge into the sanitary sewer system. The contractor would be required to comply with the plan and applicable Federal, State and local laws.

- Notify appropriate Federal, State and local agencies if evidence of previously undiscovered soil or groundwater contamination is encountered during construction. Any contaminated areas would be cleaned up in accordance with the recommendations of the Central Valley Regional Water Quality Control Board (Regional Board), California DTSC or other appropriate Federal, State or local regulatory agencies.
- A worker health and safety plan would be prepared before the start of construction that identifies, at a minimum, all contaminants that could be encountered during construction; all appropriate worker, public health and environmental protection equipment and procedures to be used during project activities; emergency response procedures; the most direct route to the nearest hospitals; and a Site Safety Officer. The plan would describe actions to be taken if hazardous materials are encountered on-site, including protocols for handling hazardous materials, preventing their spread and emergency procedures to be taken in the event of a spill.
- Retain licensed contractors to remove all underground storage tanks.

Cultural Resources

NEPA Mitigation Measures

Section 5.21.10 in the 2018 LSJR IIFR/EIS/EIR references the following measures and would be implemented.

USACE began consultation concerning a PA with SHPO and Native American Tribes. A fully executed PA will be in place prior to project implementation. Specific mitigation measures would be developed in accordance with the PA to address any adverse effects on historic properties through the development of an Historic Property Treatment Plan (HPTP). The HPTP would guide the level of data recovery, mitigation or actions taken to resolve adverse effects to the historic property. The main requirements of the contents of a research design and HPTP are located in the PA Depending on the nature of the adverse effect, actions to protect or mitigate for adverse effects to historic properties may include the following:

- Redesigning the project to avoid historic properties or sensitive areas.

- Conducting data recovery excavations of archaeological sites that cannot be avoided or are discovered during construction, based on an approved HPTP.
- Monitoring all ground disturbing construction activities in areas where buried resources are anticipated.
- Surveying and protecting exposed inundated cultural deposits.
- Protecting exposed archaeological sites from vandalism and erosion with fencing and revegetation or capping sites in an approved manner with appropriate material.
- Preparing and implementing an inadvertent discovery plan.
- If previously undiscovered resources are identified during an undertaking, suspend work while the resource is evaluated and mitigated to avoid any further impact.
- Continue to consult with Native American or other groups to identify any traditional cultural properties or resource uses and address impacts.
- If human remains are discovered during any activities associated with bank protection measures, USACE, CVFPB and SJAFCA and their contractors will comply with State and Federal laws relating to the discovery and identification of human remains. In the case of Native American human remains found on non-Federal land, USACE and DWR will consult with the most likely descendant of the deceased regarding the disposition of human remains and associated burial items pursuant to the PA. This process includes contacting the coroner and developing a plan for the removal or protection of the remains pursuant to the PA.

CEQA Mitigation Measures

Mitigation Measures 3.7-1, 3.7-2, and 3.7-3 from the 2023 TS30L Final SEIR shall apply.

Mitigation Measure 3.7-1: Cultural Resources Awareness Training. USACE in consultation with SJAFCA and other interested parties shall provide a cultural resources and tribal cultural resources sensitivity and awareness training program for all personnel involved in Modified Project construction, including field consultants and construction workers. The training shall be developed in coordination with an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for Archeology, as well as culturally and geographically affiliated Native American tribes. SJAFCA may invite Native American representatives from interested culturally and geographically affiliated Native American Tribes to participate. The training shall be conducted before any Modified Project–related construction activities begin and shall include relevant information regarding sensitive cultural resources and tribal cultural resources, including applicable regulations, protocols for avoidance, and consequences of violating federal and state laws and regulations.

The training shall also describe appropriate avoidance and impact minimization measures for cultural resources and tribal cultural resources that could be located on the Modified Project site and shall outline what to do and whom to contact if any potential cultural resources or tribal cultural resources are encountered. The training shall emphasize the requirement for confidentiality and culturally appropriate treatment of any discovery of significance to Native American Tribes and shall discuss appropriate behaviors and responsive actions, consistent with Native American tribal values.

Mitigation Measure 3.7-2: Inadvertent Discovery of Cultural Materials. If an inadvertent discovery of cultural materials (e.g., unusual amounts of shell, animal bone, any human remains, bottle glass, ceramics, building remains), tribal cultural resources, sacred sites, or landscapes is made at any time during Project-related construction activities, USACE in consultation with SJAFCA and other interested parties, and in coordination with an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for Archeology and culturally and geographically affiliated Native American tribes, shall develop appropriate protection and avoidance measures where feasible. These procedures shall be developed in accordance with the Lower San Joaquin River Feasibility Study Project PA and associated HPMP, which specifies procedures for post-review discoveries. Additional measures, such as development of a Historic Properties Treatment Plan prepared in accordance with the PA and HPMP, may be necessary if avoidance or protection is not possible.

Mitigation Measure 3.7-3: Inadvertent Discovery of Human Remains. In accordance with the California Health and Safety Code, if human remains are uncovered during ground-disturbing activities, USACE shall immediately halt potentially damaging excavation in the area of the burial and notify the County coroner and an archaeologist meeting the Secretary of the Interior's Professional Qualifications Standards for Archeology to determine the nature of the remains. The coroner is required to examine all discoveries of human remains within 48 hours of receiving notice of a discovery on private or state lands (HSC Section 7050.5[b]). If the coroner determines that the remains are those of a Native American, they must contact the NAHC by phone within 24 hours of making that determination (HSC Section 7050[c]). After the coroner's findings have been made, the archaeologist and the NAHC-designated Most Likely Descendant (MLD), in consultation with USACE and SJAFCA, shall determine the ultimate treatment and disposition of the remains.

Upon the discovery of Native American human remains, USACE in coordination with SJAFCA, shall require that all construction work stop within 100 feet of the discovery until consultation with the MLD has taken place. The MLD shall have 48 hours to complete a site inspection and make recommendations to the USACE and SJAFCA after being granted access to the site. A range of possible treatments for the remains, including nondestructive removal and analysis, preservation in place, relinquishment of the remains and associated items to the descendants, or other culturally appropriate treatment may be discussed. PRC Section 5097.98(b)(2) suggests that the concerned parties may mutually agree to extend discussions beyond the initial 48 hours to allow for the discovery of additional remains. If agreed to by the MLD, SJAFCA or SJAFCA's authorized representative shall rebury the Native American human remains and associated grave goods with appropriate dignity on the property in a location not subject to further subsurface disturbance. Construction work in the vicinity of the burials shall not resume until the mitigation is completed.

APPENDIX G

U.S. Department of Agriculture Farmland Conversion Impact Rating

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request
Name of Project LSJR 14 Mile Pumpstation Parcel	Federal Agency Involved USACE
Proposed Land Use Mitigaiton	County and State SJAFCA and DWR
PART II *(To be completed by NRCS)*	Date Request Received By NRCS 03/26/2025 / Person Completing Form: Philip Smith

Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	YES ✔	NO ☐	Acres Irrigated 487,147	Average Farm Size 225

Major Crop(s) Apiary Products, Nursery Products and Apiary Produ	Farmable Land In Govt. Jurisdiction Acres: 721,377 % 79.1	Amount of Farmland As Defined in FPPA Acres: 614,129 % 67.3
Name of Land Evaluation System Used CA Revised Storie Index	Name of State or Local Site Assessment System N/A	Date Land Evaluation Returned by NRCS 03/31/2025

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		85.84			
B. Total Acres To Be Converted Indirectly		0			
C. Total Acres In Site		85.84			
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		85.84			
B. Total Acres Statewide Important or Local Important Farmland		0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.014			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		58.48			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)		45			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	13			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	0			
6. Distance To Urban Support Services	(15)	0			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	0			
10. On-Farm Investments	(20)	0			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	23	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	45	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	23	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	68	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? YES ☐ NO ✔

Reason For Selection:

Name of Federal agency representative completing this form: Jessica Agajan	Date: 3/25/2025

(See Instructions on reverse side) **Form AD-1006 (03-02)**

LOWER SAN JOAQUIN RIVER PROJECT
COMPENSATORY MITIGATION PLAN (CMP)
FOURTEENMILE SLOUGH PUMPSTATION

San Joaquin County Important Farmland
California Department of Conservation
Division of Land Resource Protection
Farmland Mapping and Monitoring Program

Land Type

Farmland of Local Importance (L)

Nonagricultural and Natural Vegetation (nv)

US Army Corps of Engineers
Sacramento District

Miles
0 0.05 0.1 0.15 0.2

N

U.S. Department of Agriculture

FARMLAND CONVERSION IMPACT RATING

PART I *(To be completed by Federal Agency)*	Date Of Land Evaluation Request
Name of Project LSJR 14 Mile Pumpstation Parcel	Federal Agency Involved USACE
Proposed Land Use Mitigaiton	County and State SJAFCA and DWR

PART II *(To be completed by NRCS)*	Date Request Received By NRCS 03/26/2025	Person Completing Form: Philip Smith

	YES	NO	Acres Irrigated	Average Farm Size
Does the site contain Prime, Unique, Statewide or Local Important Farmland? *(If no, the FPPA does not apply - do not complete additional parts of this form)*	☑	☐	487,147	225

Major Crop(s)	Farmable Land In Govt. Jurisdiction	Amount of Farmland As Defined in FPPA
Apiary Products, Nursery Products and Apiary Produ	Acres: 721,377 % 79.1	Acres: 614,129 % 67.3
Name of Land Evaluation System Used	Name of State or Local Site Assessment System	Date Land Evaluation Returned by NRCS
CA Revised Storie Index	N/A	03/31/2025

PART III *(To be completed by Federal Agency)*		Alternative Site Rating			
		Site A	Site B	Site C	Site D
A. Total Acres To Be Converted Directly		85.84			
B. Total Acres To Be Converted Indirectly		0			
C. Total Acres In Site		85.84			
PART IV *(To be completed by NRCS)* Land Evaluation Information					
A. Total Acres Prime And Unique Farmland		85.84			
B. Total Acres Statewide Important or Local Important Farmland		0			
C. Percentage Of Farmland in County Or Local Govt. Unit To Be Converted		0.014			
D. Percentage Of Farmland in Govt. Jurisdiction With Same Or Higher Relative Value		58.48			
PART V (To be completed by NRCS) Land Evaluation Criterion Relative Value of Farmland To Be Converted (Scale of 0 to 100 Points)		45			
PART VI *(To be completed by Federal Agency)* Site Assessment Criteria *(Criteria are explained in 7 CFR 658.5 b. For Corridor project use form NRCS-CPA-106)*	**Maximum Points**	Site A	Site B	Site C	Site D
1. Area In Non-urban Use	(15)	13			
2. Perimeter In Non-urban Use	(10)	10			
3. Percent Of Site Being Farmed	(20)	0			
4. Protection Provided By State and Local Government	(20)	0			
5. Distance From Urban Built-up Area	(15)	0			
6. Distance To Urban Support Services	(15)	0			
7. Size Of Present Farm Unit Compared To Average	(10)	0			
8. Creation Of Non-farmable Farmland	(10)	0			
9. Availability Of Farm Support Services	(5)	0			
10. On-Farm Investments	(20)	0			
11. Effects Of Conversion On Farm Support Services	(10)	0			
12. Compatibility With Existing Agricultural Use	(10)	0			
TOTAL SITE ASSESSMENT POINTS	160	23	0	0	0
PART VII ***(To be completed by Federal Agency)***					
Relative Value Of Farmland *(From Part V)*	100	45	0	0	0
Total Site Assessment *(From Part VI above or local site assessment)*	160	23	0	0	0
TOTAL POINTS *(Total of above 2 lines)*	260	68	0	0	0

Site Selected:	Date Of Selection	Was A Local Site Assessment Used? YES ☐ NO ☑

Reason For Selection:

Name of Federal agency representative completing this form: Jessica Agajan	Date: 3/25/2025

(See Instructions on reverse side) **Form AD-1006 (03-02)**

LOWER SAN JOAQUIN RIVER PROJECT
COMPENSATORY MITIGATION PLAN (CMP)
MANTECA PARCEL

San Joaquin County Important Farmland
California Department of Conservation
Division of Land Resource Protection
Farmland Mapping and Monitoring Program

Land Type

- Prime Farmland (P)
- Farmland of Statewide Importance (S)
- Unique Farmland (U)
- Nonagricultural and Natural Vegetation (nv)

US Army Corps of Engineers
Sacramento District

Miles
0 0.1 0.2 0.3 0.4

N

STEPS IN THE PROCESSING THE FARMLAND AND CONVERSION IMPACT RATING FORM

Step 1 - Federal agencies (or Federally funded projects) involved in proposed projects that may convert farmland, as defined in the Farmland Protection Policy Act (FPPA) to nonagricultural uses, will initially complete Parts I and III of the form. For Corridor type projects, the Federal agency shall use form NRCS-CPA-106 in place of form AD-1006. The Land Evaluation and Site Assessment (LESA) process may also be accessed by visiting the FPPA website, http://fppa.nrcs.usda.gov/lesa/.

Step 2 - Originator (Federal Agency) will send one original copy of the form together with appropriate scaled maps indicating location(s)of project site(s), to the Natural Resources Conservation Service (NRCS) local Field Office or USDA Service Center and retain a copy for their files. (NRCS has offices in most counties in the U.S. The USDA Office Information Locator may be found at http://offices.usda.gov/scripts/ndISAPI.dll/oip_public/USA_map, or the offices can usually be found in the Phone Book under U.S. Government, Department of Agriculture. A list of field offices is available from the NRCS State Conservationist and State Office in each State.)

Step 3 - NRCS will, within 10 working days after receipt of the completed form, make a determination as to whether the site(s) of the proposed project contains prime, unique, statewide or local important farmland. (When a site visit or land evaluation system design is needed, NRCS will respond within 30 working days.

Step 4 - For sites where farmland covered by the FPPA will be converted by the proposed project, NRCS will complete Parts II, IV and V of the form.

Step 5 - NRCS will return the original copy of the form to the Federal agency involved in the project, and retain a file copy for NRCS records.

Step 6 - The Federal agency involved in the proposed project will complete Parts VI and VII of the form and return the form with the final selected site to the servicing NRCS office.

Step 7 - The Federal agency providing financial or technical assistance to the proposed project will make a determination as to whether the proposed conversion is consistent with the FPPA.

INSTRUCTIONS FOR COMPLETING THE FARMLAND CONVERSION IMPACT RATING FORM

(For Federal Agency)

Part I: When completing the "County and State" questions, list all the local governments that are responsible for local land use controls where site(s) are to be evaluated.

Part III: When completing item B (Total Acres To Be Converted Indirectly), include the following:

1. Acres not being directly converted but that would no longer be capable of being farmed after the conversion, because the conversion would restrict access to them or other major change in the ability to use the land for agriculture.
2. Acres planned to receive services from an infrastructure project as indicated in the project justification (e.g. highways, utilities planned build out capacity) that will cause a direct conversion.

Part VI: Do not complete Part VI using the standard format if a State or Local site assessment is used. With local and NRCS assistance, use the local Land Evaluation and Site Assessment (LESA).

1. Assign the maximum points for each site assessment criterion as shown in § 658.5(b) of CFR. In cases of corridor-type project such as transportation, power line and flood control, criteria #5 and #6 will not apply and will, be weighted zero, however, criterion #8 will be weighed a maximum of 25 points and criterion #11 a maximum of 25 points.

2. Federal agencies may assign relative weights among the 12 site assessment criteria other than those shown on the FPPA rule after submitting individual agency FPPA policy for review and comment to NRCS. In all cases where other weights are assigned, relative adjustments must be made to maintain the maximum total points at 160. For project sites where the total points equal or exceed 160, consider alternative actions, as appropriate, that could reduce adverse impacts (e.g. Alternative Sites, Modifications or Mitigation).

Part VII: In computing the "Total Site Assessment Points" where a State or local site assessment is used and the total maximum number of points is other than 160, convert the site assessment points to a base of 160.
Example: if the Site Assessment maximum is 200 points, and the alternative Site "A" is rated 180 points:

$$\frac{\text{Total points assigned Site A}}{\text{Maximum points possible}} = \frac{180}{200} \text{ X } 160 = 144 \text{ points for Site A}$$

For assistance in completing this form or FPPA process, contact the local NRCS Field Office or USDA Service Center.

NRCS employees, consult the FPPA Manual and/or policy for additional instructions to complete the AD-1006 form.