SAN JOAQUIN RIVER
RESTORATION PROGRAM

Programmatic Biological Assessment

November 2011

Table of Contents

Tables

Figures

Appendices

List of Abbreviations and Other Acronyms

ºF	degrees Fahrenheit
Act	San Joaquin River Restoration Settlement Act
AFRP	Anadromous Fish Restoration Program
ATR	Annual Technical Report
BA	biological assessment
BO	biological opinion
CEQA	California Environmental Quality Act
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
cfs	cubic feet per second
CNDDB	California Natural Diversity Database
CNPS	California Native Plant Society
COA	Coordinated Operations Agreement
CVFPB	Central Valley Flood Protection Board
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
CWA	Clean Water Act
DCC	Delta Cross Channel
Delta	Sacramento–San Joaquin Delta
DFG	California Department of Fish and Game
DMC	Delta-Mendota Canal
DO	dissolved oxygen
DPS	distinct population segment
DWR	California Department of Water Resources
DWSC	Deep Water Ship Channel
EA	EA Engineering, Science, and Technology
EC	Electrical conductivity
ECPWG	Environmental Compliance Permitting and Work Group
EFH	essential fish habitat
ESA	Endangered Species Act
ESU	evolutionarily significant unit
FERC	Federal Energy Regulatory Commission
FMP	Fisheries Management Plan
FR	Federal Register
HCP	habitat conservation plans
IWM	instream woody material
km	kilometer
LSJLD	Lower San Joaquin Levee District
LSZ	low-salinity zone

M&I	municipal and industrial
mm	millimeter
ND	Negative Declaration
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NOP	Notice of Preparation
NRDC	Natural Resources Defense Council
NWR	National Wildlife Refuge
OMR	Old and Middle rivers
PCB	polychlorinated biphenyls
PEIS/R	the Draft Program Environmental Impact Statement/Environmental Impact Report
PFMC	Pacific Fishery Management Council
ppt	parts per thousand
RA	Restoration Administrator
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RM	river mile
RPA	Reasonable and prudent alternatives
RWA	Recovered Water Account
RWQCB	Regional Water Quality Control Boards
Secretary	Secretary of the Interior
Settlement	Stipulation of Settlement in NRDC, et al,. v. Kirk Rodgers, et al.
SJRGA	San Joaquin River Group Authority
SJRRP	San Joaquin River Restoration Program
SOG	Stanislaus Operations Group
SR	State Route
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	thousand acre-feet
USACE	U.S. Army Corps of Engineers
USC	U.S. Code
USFWS	U.S. Fish and Wildlife Service
USGS	U.S. Geological Survey
VAMP	Vernalis Adaptive Management Program
WOMT	Water Operations Management Team
WRPC	Watershed Restoration and Protection Council
WY	Water Year
YOY	young-of-the-year

Chapter 1.0 Introduction

The San Joaquin River Restoration Program (SJRRP) was established in late 2006 to implement the Stipulation of Settlement in *NRDC, et al., v. Kirk Rodgers, et al.*, (Settlement). Authorization for implementing the Settlement is provided in the San Joaquin River Restoration Settlement Act (Act), included in Public Law 111-11. The Settlement establishes two primary goals:

- **Restoration Goal –** To restore and maintain fish populations in “good condition” in the main stem 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.

- **Water Management Goal –** To reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim and Restoration flows provided for in the Settlement.

The U.S. Department of the Interior, Bureau of Reclamation (Reclamation), as the Federal lead agency, has prepared this Biological Assessment (BA) in compliance with Section 7 of the Federal Endangered Species Act (ESA) (16 U.S. Code (USC) 1536(c)).

1.1 Purpose

The purpose of this BA is to review the Proposed Action in detail sufficient to determine the extent to which implementing the Settlement may affect any species that are Federally listed or proposed for listing as threatened or endangered under the jurisdiction of the National Marine Fisheries Service (NMFS) and U.S. Fish and Wildlife Service (USFWS). This BA analyzes direct, indirect, interrelated/interdependent, and cumulative effects of Reclamation’s Proposed Action on Federally listed and proposed species and designated and proposed critical habitat. As mentioned, this BA has been prepared in accordance with requirements set forth under Section 7 of the ESA, described in the following section, and will be used by NMFS and USFWS to analyze the Proposed Action as part of the Section 7 consultation and prepare Biological Opinions (BOs) on the implementation of the Settlement, if needed.

1.1.1 Regulatory Framework

Under provisions of Section 7(a)(2) of the ESA, a Federal agency that permits, licenses, funds, or otherwise authorizes activities must consult with NMFS or USFWS, as appropriate, to prevent its action from jeopardizing the continued existence of any listed species or adversely modifying critical habitat (16 USC 1536(c)). A Federal agency is required to consult if an action “may affect” listed species or designated critical habitat.

The term “biological assessment” refers to the information prepared by, or under the direction of, the Federal agency concerning listed species and species proposed for listing, as well as designated and proposed critical habitat that may be present in the Action Area (defined below), and to the evaluation of the potential effects of the action on those species and habitat (50 Code of Federal Regulations (CFR) Section 402.2). A BA must be prepared if listed species or critical habitat may be present in an area to be affected by a “major construction activity.” When a Federal agency determines, through a BA or other review, that its action is “likely to adversely affect” a listed species or designated critical habitat, the agency must submit a request for formal consultation to NMFS and USFWS. There is a designated period of time (90 days) for this consultation to take place and, subsequently, another set period of time (45 days) for NMFS and USFWS to prepare BOs. The BOs present determinations by NMFS and USFWS as to whether or not the Proposed Action would be likely to jeopardize the species or adversely modify its critical habitat. If a “jeopardy” or “adverse modification” determination is made, the BO must identify any reasonable and prudent alternative actions that could satisfy the purpose and need for the action.

If NMFS and USFWS issue either a “nonjeopardy” opinion or a “jeopardy” opinion that contains reasonable and prudent alternatives, the opinion may include an incidental take statement. NMFS and USFWS must anticipate the quantity of take that may result from the Proposed Action and authorize such take with a statement that the listed species therein will not be jeopardized. The incidental take statement must contain clear terms and conditions designed to reduce the impact of the anticipated take; these terms are binding on the Federal agency.

In addition to compliance with ESA, Reclamation is required to comply with the Magnuson-Stevens Fishery Conservation and Management Act (Public Law 94-265). Under this act, Federal agencies are to take immediate action to conserve and manage the fisheries found off the coasts of the United States, and the Nation’s anadromous species and continental shelf fishery resources. Consultation with NMFS is required when any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken, may adversely affect Essential Fish Habitat (EFH).

1.1.2 Proposed Action

The purpose of the Proposed Action is to implement the Settlement consistent with the Act. The Act authorizes and directs the Secretary of the U.S. Department of the Interior (Secretary) to implement the Settlement. The Settlement specifies the project need, which requires changes to the operation of Friant Dam to support achieving the Restoration Goal while reducing or avoiding adverse impacts to Friant Division long-term contractors’ water deliveries caused by releasing Interim or Restoration flows to support achieving the Water Management Goal.

This BA analyzes two levels of actions, program level and project level. The program-level, or first-tier, analysis of the Proposed Action evaluates the actions identified in the Settlement. (See Chapter 3.0, “Description of Proposed Action,” for further detail on Settlement actions.) For actions evaluated at a program level of detail, subsequent analysis pursuant to ESA and/or the California Endangered Species Act (CESA) would be required at a project level of detail. A potential range of future construction and management actions is included in the Proposed Action to bracket the probable range of effects of program-level actions. This bracketed range of potential effects also will allow for an informed analysis of system-wide and cumulative effects resulting from implementing the entirety of the Settlement. This BA also includes more detailed project-level analysis of certain actions fully described in the Proposed Action.

Program-level actions include modifying Reach 4B1 to convey at least 475 cubic feet per second (cfs), with the Eastside and Mariposa bypasses conveying any remaining Restoration Flows, and also include the potential for recirculating all recaptured Interim and Restoration flows. In addition, program-level actions include additional restoration actions, such as reintroducing spring-run Chinook salmon downstream from Friant Dam, enhancing spawning gravel and in-channel habitat, modifying structures and channels to achieve the Restoration Goal, and recirculating recaptured Interim and Restoration flows to Friant Division long-term contractors.

This BA also includes the effects to listed and proposed species from more detailed project-level analysis of the following actions:

- Reoperate Friant Dam and downstream flow-control structures to release Interim and Restoration flows to the San Joaquin River, as constrained by then-existing channel capacities, and make water supplies available to Friant Division long-term contractors at a preestablished rate (Reclamation action).

- Provide additional funding to support additional maintenance activities, including patrolling to assess levee conditions when increased potential for seepage is identified through monitoring, as described in the Physical Monitoring and Management Plan (see Appendix D of the *Draft Program Environmental Impact Statement/Environmental Impact Report* (PEIS/R) for the SJRRP (Reclamation and DWR 2011a)); performing any additional operations and maintenance needed on flap gates in the Eastside and Mariposa bypasses, at the Chowchilla Bypass Bifurcation Structure, at the Eastside Bypass Bifurcation Structure, or at the Mariposa Bypass Bifurcation Structure to facilitate routing Interim and Restoration flows; and removing vegetation and sediment by mechanical or chemical means that would cause Interim or Restoration flows to exceed channel capacity (Reclamation action).

- Recapture Interim and Restoration flows at existing facilities within the San Joaquin River between Friant Dam and the confluence with the Merced River (also referred to as the Restoration Area) and in the Delta (Reclamation action).

- Reduce, redirect, or redivert Interim or Restoration flows to reduce flow in downstream reaches to address any issues identified through implementation of the Physical Monitoring and Management Plan (see Appendix D of the Draft PEIS/R, Reclamation and DWR 2011a) (Reclamation action).

- Modify releases from Friant Dam to adjust flows to flush or mobilize spawning gravel based on monitoring reports and recommendations on spawning gravel conditions (Reclamation action).

- Grant an order by the State Water Resources Control Board (SWRCB) for the downstream protection and rediversion of Interim and Restoration flows (SWRCB action, serving as a California Environmental Quality Act (CEQA) Responsible Agency).

1.2 Baseline Condition

Consistent with ESA, the effects analysis presented in this BA compares the Proposed Action under consideration to the environmental baseline. The environmental baseline is defined, for purposes of this analysis, as the existing conditions in place at the time when the Notice of Preparation (NOP) for the Draft PEIS/R was published (August 22, 2007). This is equivalent to the existing conditions evaluated in the Draft PEIS/R, and does not include the release of Interim Flows, which began in October 2009.

The effects analysis presented in Chapter 6.0, “Effects,” and summarized in Chapter 7.0, “Conclusions,” as well as the impacts assessment presented in the Draft PEIS/R, analyze the potential effects of the Proposed Action, including Interim Flows, as compared to conditions in place in 2007 prior to the release of Interim Flows (environmental baseline). Where relevant, information collected during the release of Interim Flows is used to inform the effects analysis presented in subsequent chapters of this BA.

1.3 Action Area

Action Area is defined as “…all areas that would be affected directly or indirectly by the Federal action, not strictly the immediate area involved in the action” (USFWS and NMFS 1998). The Action Area encompassed in this BA includes all areas where listed and proposed species and designated and proposed critical habitat could be affected by the Proposed Action (see Figure 1-1), and specifically covers the following areas:

- San Joaquin River upstream from Friant Dam, including Millerton Lake, to Kerckhoff Dam.

- San Joaquin River from Friant Dam to the Merced River confluence (Restoration Area), including Reaches 1 through 5 and portions of the flood management system, and extending approximately 4,000 feet outward along either side of the San Joaquin River and the Eastside and Mariposa bypasses.

- San Joaquin River from the Merced River to the Delta, and including tributaries.

- South Delta, which is defined as the San Joaquin River within the Delta west to its confluence with the Sacramento River.

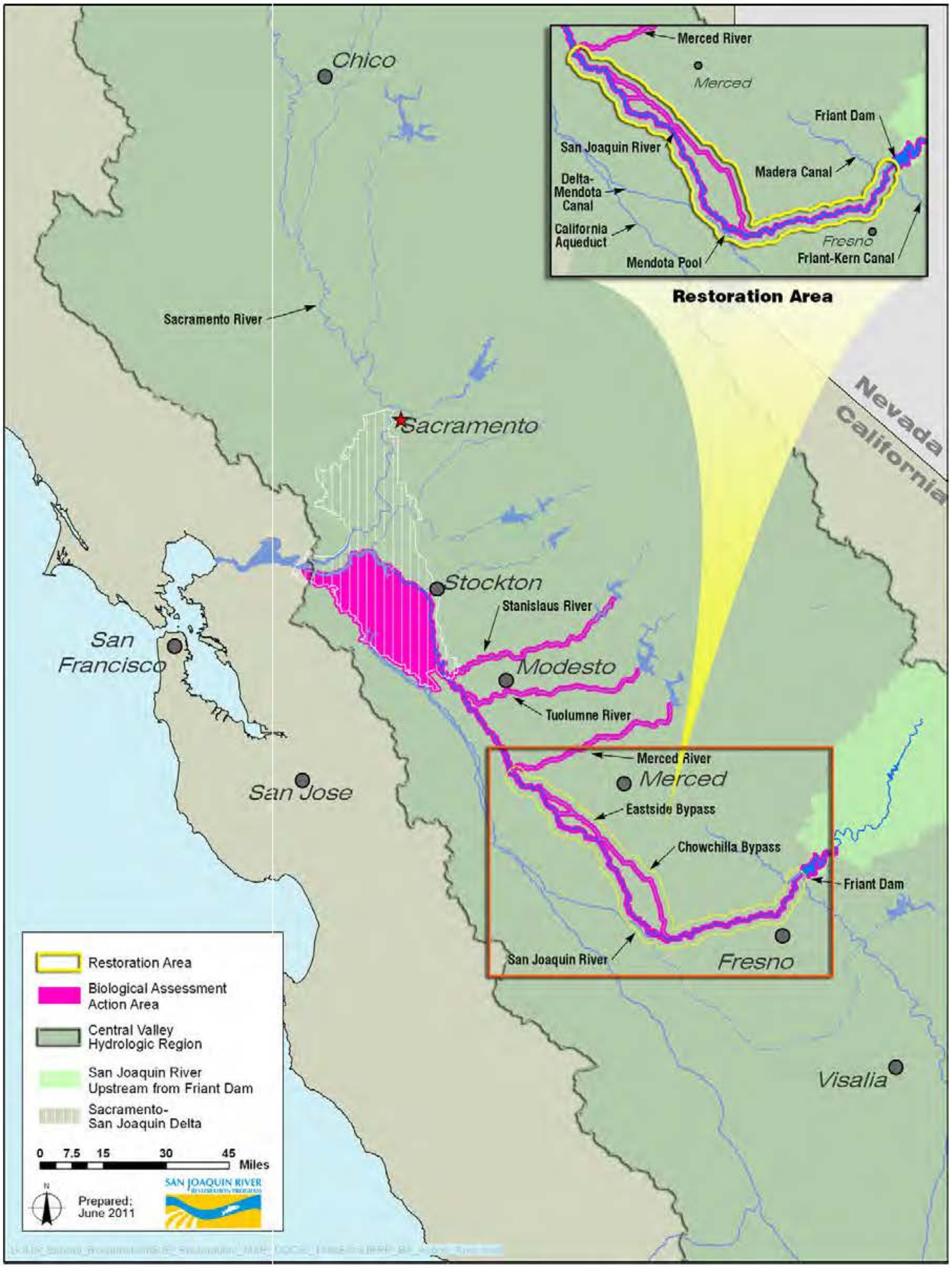

Figure 1-1.
Action Area for the Proposed Action

1.4 Species Evaluated

This BA evaluates the effects of the Proposed Action on threatened, endangered, proposed threatened, proposed endangered, or candidate species and any designated or proposed critical habitat within the Action Area under the jurisdiction of NMFS and USFWS. Appendix A, "USFWS Species List Response Letter," includes the species list from USFWS that encompasses the Action Area.

1.4.1 Species Included in Analysis

Table 1-1 identifies the Federally listed fish, plant, and wildlife species that are addressed in this BA.

Table 1-1.
Federally Listed Species Within the Action Area

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Fish				
Central Valley steelhead distinct population segment (DPS) *Oncorhynchus mykiss*	T	Designated critical habitat in the Action Area (70 *Federal Register* 52488–52536, September 2, 2005)	Cold, freshwater streams with suitable gravel for spawning in the Sacramento and San Joaquin river basins; rears in seasonally inundated floodplains, rivers, tributaries, and Sacramento-San Joaquin (Delta)	San Joaquin River from Merced Confluence to Delta, Merced River, Tuolumne River, Stanislaus River, south Delta
Central Valley fall-run Chinook salmon evolutionarily significant unit (ESU) *Oncorhynchus tshawytscha*	SC	N/A	Cold, freshwater streams with suitable gravel for spawning in the Sacramento and San Joaquin river basins; rears in seasonally inundated floodplains, rivers, tributaries, and Delta	San Joaquin River from Merced Confluence to Delta, Merced River, Tuolumne River, Stanislaus River, south Delta
Central Valley spring-run Chinook salmon ESU *Oncorhynchus tshawytscha*	T	Designated critical habitat not within the Action Area (70 *Federal Register* 52488–52536, September 2, 2005)	Spawns in Sacramento River tributaries; rears in seasonally inundated floodplains, rivers, tributaries, and Delta	south Delta
Sacramento River winter-run Chinook salmon ESU *Oncorhynchus tshawytscha*	E	Designated critical habitat not within the Action Area (58 *Federal Register* 33212–33219, June 16, 1993)	Spawns in Sacramento River between Keswick Dam and Red Bluff Diversion Dam; rears in seasonally inundated floodplains, rivers, tributaries, and Delta	south Delta

Table 1-1.
Federally Listed Species Within the Action Area (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Southern DPS of the North American green sturgeon *Acipenser medirostris*	T	Designated critical habitat in the Action Area (74 *Federal Register* 52300-52321, October 9, 2009)	Spawning locations unknown, but requires cold, freshwater rivers with suitable gravel for spawning; rears in seasonally inundated floodplains, rivers, tributaries, and Delta	Potentially occurs in San Joaquin River downstream from Merced confluence, south Delta
Delta smelt *Hypomesus transpacificus*	T	Designated critical habitat in the Action Area (59 *Federal Register* 65256–65279, December 19, 1994)	Endemic to the Delta, although occasionally found in the Sacramento and San Joaquin rivers upstream from the Delta. Spawns in tidally influenced freshwater wetlands and seasonally submerged uplands; rears in seasonally inundated floodplains, tidal marsh, and Delta	San Joaquin River downstream from Stanislaus River confluence, south Delta
Pacific lamprey *Lampetra tridentata*	SC	N/A	Require cold freshwater rivers with higher velocities and gravel-sized substrate for spawning. Larvae rear in sandy substrates	San Joaquin River from Merced Confluence to Delta, Merced River, Tuolumne River, Stanislaus River, south Delta
Plants				
Succulent owl's-clover *Castilleja campestris ssp. succulenta*	T	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Northern claypan and northern hardpan vernal pools on alluvial terraces or northern basalt flow vernal pools, often acidic soils; 160–2,500 feet in elevation	Known to occur near, but not within, the Restoration Area boundary in Reach 1
Hoover's spurge *Chamaesyce hooveri*	T	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Relatively deep, northern hardpan and northern claypan vernal pools on alluvial fans or terraces of ancient rivers or streams; neutral to saline-alkaline soils over lime-silica cemented hardpan or claypan in the San Joaquin Valley or acidic soils over iron-silica cemented hardpan in the Sacramento Valley; usually in areas devoid of competing vegetation; 80 feet to 820 feet in elevation	Known to occur near, but not within, the Restoration Area boundary in Reaches 4B1 and 4B2

Table 1-1.
Federally Listed Species Within the Action Area (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Palmate-bracted bird's-beak *Cordylanthus palmatus*	E	None designated	Alkaline soils in chenopod scrub and valley and foothill grassland; 15 feet to 500 feet in elevation	Known to occur near, but not within, the Restoration Area boundary, in Reaches 2A and 3 (Alkali Sink Ecological Area, Mendota NWR)
Colusa grass *Neostapfia colusana*	T	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Large, relatively deep northern claypan and northern hardpan vernal pools on the rim of alkaline basins or acidic soils of alluvial fans and stream terraces; lime-silica cemented hardpan in the San Joaquin Valley basins to iron-silica cemented hardpan in eastern margin of the San Joaquin Valley; 15 feet to 4,000 feet in elevation	Known to occur near, but not within, the Restoration Area boundary in Reaches 4B1 and 4B2
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	T	Designated critical habitat adjacent to the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Northern claypan, northern hardpan, and northern basalt flow vernal pools on alluvial fans, high- and low-stream terraces, and tabletop lava flows; acidic soils over iron-silica cemented hardpan, tuffaceous alluvium, and basaltic rock from ancient volcanic flows; 30 feet to 2,500 feet in elevation	Known to occur in Restoration Area in and near Reach 1A
Hairy Orcutt grass *Orcuttia pilosa*	E	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Northern hardpan and northern claypan vernal pools on high- or low-stream terraces and alluvial fans; found on both acidic and saline-alkaline soils with iron-silica cemented hardpan or claypan; 175 feet to 650 feet in elevation	Known to occur near, but not within, the Restoration Area boundary in Reach 1A

**Table 1-1.
Federally Listed Species Within the Action Area (contd.)**

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Greene's tuctoria *Tuctoria greenei*	E	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Northern basalt flow, northern claypan, and northern hardpan vernal pools underlain by iron-silica cemented hardpan, tuffaceous alluvium, or claypan; 110 feet to 3,500 feet in elevation	Not known to occur in the Action Area, although historically known from vernal pool habitat near the Stanislaus and Tuolumne rivers
Invertebrates				
Conservancy fairy shrimp *Branchinecta conservatio*	E	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Vernal pools and swales	Known to occur in suitable habitat in and adjacent to the Restoration Area in Reaches 4B2 and 5 (San Luis NWR Complex) and Eastside Bypass
Longhorn fairy shrimp *Branchinecta longiantenna*	E	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Vernal pools and swales	Known to occur in suitable habitat in and adjacent to the Restoration Area in Reach 5 (San Luis NWR Complex)
Vernal pool fairy shrimp *Branchinecta lynchi*	T	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Vernal pools and other seasonal wetlands	Known to occur in suitable habitat in and adjacent to the Restoration Area in Reaches 4B1, 4B2, and 5 (San Luis NWR Complex) and in the Chowchilla and Eastside bypasses
Vernal pool tadpole shrimp *Lepidurus packardi*	E	Designated critical habitat in the Action Area (70 *Federal Register* 46924–46999, August 11, 2005)	Vernal pools, swales, and other ephemeral wetlands	Known to occur in suitable habitat in and adjacent to the Restoration Area in Reaches 4B1, 4B2, and 5 (San Luis NWR Complex, Great Valley Grasslands State Park), and the Chowchilla and Eastside bypasses

**Table 1-1.
Federally Listed Species Within the Action Area (contd.)**

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	T	No designated critical habitat in the Action Area (45 *Federal Register* 52803–52807, August 8, 1980)	Elderberry shrubs, typically in riparian habitats	Known to occur in elderberry shrubs present in and adjacent to the Restoration Area along Reaches 1A and 2
Amphibians				
California tiger salamander *Ambystoma californiense*	T	Designated critical habitat in the Action Area (70 *Federal Register* 49379–49458, August 23, 2005)	Small ponds, lakes, or vernal pools in grasslands or oak woodlands	Known to occur in suitable habitat in and adjacent to the Restoration Area along Reaches 4B2 and 5 (West Bear Creek Unit of the San Luis NWR Complex, Great Valley Grasslands State Park)
Reptiles				
Blunt-nosed leopard lizard *Gambelia sila*	E	None designated	Open habitats with scattered low bushes on alkali flats, plains, washes, and arroyos	Known to occur in suitable habitat near the Restoration Area along Reach 2B (Mendota Pool) and in the Chowchilla Bypass
Giant garter snake *Thamnophis gigas*	T	None designated	Streams, sloughs, ponds, and irrigation/drainage ditches; requires upland refugia not subject to flooding during its inactive season	Known to occur in suitable habitat near the Restoration Area near Reach 2B (Mendota Wildlife Area) and near Reaches 4B2 and 5 (San Luis, Kesterson, and West Bear Creek units of the San Luis NWR Complex)

Table 1-1.
Federally Listed Species Within the Action Area (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Birds				
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	C	None designated	Inhabits wide, dense riparian forests with a thick understory of willows for nesting; prefers sites with a dominant cottonwood overstory for foraging	Historically known to occur in the Action Area near the confluence of the Tuolumne and San Joaquin rivers; Could occur in suitable habitat in the Restoration Area
Least Bell's vireo *Vireo bellii pusillus*	E	No designated critical habitat in the Action Area (59 *Federal Register* 4845–4867, February 2, 1994)	Cottonwood-willow forest, oak woodland, shrubby thickets, and dry washes with willow thickets	Known to occur in the Action Area (San Joaquin River NWR)
Mammals				
Fresno kangaroo rat *Dipodomys nitratoides exilis*	E	Designated critical habitat adjacent the Action Area (50 *Federal Register* 4222–4226, January 30, 1985)	Alkali desert scrub habitats between 200 feet and 300 feet in elevation	Known to occur near the Restoration Area along Reaches 2A and 2B (Alkali Sink Ecological Reserve, Mendota Wildlife Management Area)
San Joaquin (riparian) woodrat *Neotoma fuscipes riparia*	E	None designated	Riparian forests	Known to occur in the Action Area at the confluence of the San Joaquin and Stanislaus rivers (Caswell Memorial State Park); could occur in or near the Restoration Area, if suitable habitat is present

Table 1-1.
Federally Listed Species Within the Action Area (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Occurrence In Action Area
Riparian brush rabbit *Sylvilagus bachmani riparius*	E	None designated	Dense thickets of brush associated with riparian or chaparral habitats	Known to occur in the Action Area near the confluence of the San Joaquin and Stanislaus rivers (in Caswell Memorial State Park and near San Joaquin River NWR) and in the south Delta (along Paradise Cut)
San Joaquin kit fox *Vulpes macrotis mutica*	E	None designated	Saltbush scrub, grasslands, oak savannas, and freshwater scrub	Known to occur in and adjacent to the Restoration Area along Reaches 4B2 and 5 (West Bear Creek Unit of the San Luis NWR Complex)

Source: USFWS 2011
Key:
C = Candidate for Federal listing
Delta = Sacramento-San Joaquin Delta
DPS = distinct population segment
E = Federally listed as endangered
ESU = evolutionarily significant unit
SC = species of concern
ssp. = subspecies
T = Federally listed as threatened

1.4.2 Species Eliminated from Analysis

Certain species were eliminated from further consideration because either suitable habitat for the species or the species itself is not present in the area that could be affected by implementing the Proposed Action. Table 1-2 lists the Federally listed species identified on NMFS and USFWS species lists that would not be affected by the Proposed Action and provides supporting rationale for eliminating each species from the analysis.

Table 1-2.
Federally Listed Species Eliminated from Further Analysis

Species	Federal Status	Critical Habitat	Habitat Association	Rationale
Fish Species				
Central California coast steelhead *Oncorhynchus mykiss*	T	No designated critical habitat in the Action Area (70 *Federal Register* 52488-52536, September 2, 2005)	Drainages of San Francisco, San Pablo, and Suisun bays eastward to Chipps Island at confluence of the Sacramento and San Joaquin rivers	Unlikely to occur in the Action Area. The Action Area does not overlap the range of the species
Plants				
Chinese Camp brodiaea *Brodiaea pallida*	T	None designated.	Seeps and springs in serpentinite or volcanic soils; 1,200 feet in elevation	Unlikely to occur in the Action Area. This species is known from only two occurrences, both near Chinese Camp and outside the Action Area (north of Don Pedro Reservoir)
California jewelflower *Caulanthus californicus*	E	None designated	Saline-alkaline soils in shadscale scrub, valley and foothill grassland, pinyon-juniper woodland; zero feet to 3,000 feet in elevation	Unlikely to occur in the Action area. The only known occurrence in the vicinity has been extirpated and the only known extant occurrences are in Santa Barbara Canyon, the Carrizo Plain, and the Kreyenhagen Hills of the Mount Diablo Range
Soft bird's-beak *Cordylanthus mollis ssp. mollis*	E	No designated critical habitat in the Action Area (72 *Federal Register* 18518–18553, April 12, 2007)	Saltgrass-pickleweed marshes at or near the limits of tidal action; zero feet to 10 feet in elevation	Unlikely to occur in the Action Area. This species' current distribution is restricted to San Pablo and Suisun bays, and it has been extirpated from the Delta
Contra Costa wallflower *Erysimum capitatum ssp. angustatum*	E	No designated critical habitat in the Action Area (43 *Federal Register* 39042–39044, August 31, 1978)	Inland sand dunes; 10 feet to 65 feet in elevation	Unlikely to occur in the Action Area. This species is known from only three occurrences at the Antioch Dunes. The dunes are hydrologically isolated from the San Joaquin River and flood flows would not be altered in the dunes

Table 1-2.
Federally Listed Species Eliminated from Further Analysis (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Rationale
Contra Costa goldfields *Lasthenia conjugens*	E	No designated critical habitat in the Action Area (70 *Federal Register* 46923–46999, August 11, 2005)	Northern basalt flow, northern claypan, and northern volcanic ashflow vernal pools, swales, and moist flats; historic occurrences in saline-alkaline transition zone between vernal pool and tidal marsh habitat; known from 5 feet to 1,400 feet in elevation, but most are between 5 feet and 200 feet in elevation	Unlikely to occur in the Action Area. There are no known extant occurrences in the vicinity of the Action Area
San Joaquin woollythreads *Monolopia congdonii*	E	None designated	Alkali sinks and valley and foothill grassland with sandy soils; 200 feet to 2,650 feet in elevation	Unlikely to occur in the Action Area. Historic record of this species in the Tranquility quadrangle, but this record is several miles from the river and possibly extirpated (last seen in 1935)
Antioch Dunes evening-primrose *Oenothera deltoides ssp. howellii*	E	No designated critical habitat in the Action Area (43 *Federal Register* 39042–39044, August 31, 1978)	Inland sand dunes; 10 feet to 100 feet in elevation	Unlikely to occur in the Action Area. This species is known from only three native occurrences at the Antioch Dunes. The dunes are hydrologically isolated from the San Joaquin River and flood flows would not be altered in the dunes
Hartweg's golden sunburst *Pseudobahia bahiafolia*	E	None designated	Shallow, well-drained soils in cismontane and valley and foothill grassland habitats, especially on northern and northeastern aspects in mima mound topography; 50 feet to 500 feet in elevation	Unlikely to occur in the Action Area. This species occurs in upland habitats far above the river channel and no suitable habitat is present in the Action Area

**Table 1-2.
Federally Listed Species Eliminated from Further Analysis (contd.)**

Species	Federal Status	Critical Habitat	Habitat Association	Rationale
Red Hills (California) vervain *Verbena californica*	T	None designated	Serpentine soils in mesic areas along intermittent or perennial streams, often in overflow channels; 850 feet to 1,150 feet in elevation	Unlikely to occur in the Action Area. They are known to occur only in the Red Hills area of Tuolumne County. No suitable habitat is present in the Action Area
Wildlife				
Lange's metalmark butterfly *Apodemia mormo langei*	E	None designated	Sand dunes where the larval food plant, naked-stem buckwheat (*Eriogonum nudum ssp*. *auriculatum*) is present	Unlikely to occur in the Action Area. Historically restricted to sand dunes along the south bank of the Sacramento and San Joaquin rivers, and is currently found only at the Antioch Dunes in Contra Costa County
Giant kangaroo rat *Dipodomys ingens*	E	None designated	Annual grasslands and shrubland habitats with sparse vegetative cover	Unlikely to occur in the Action Area, although historically occurred in the region; now known to occur only in the Kettleman Hills in Kings County and western Kern County
Delta green ground beetle *Elaphrus viridis*	T	No designated critical habitat in the Action Area (45 *Federal Register* 52807–52810, August 8, 1980)	Vernal pool grasslands	Unlikely to occur in the Action Area. Only known to occur in the greater Jepson Prairie area in south-central Solano County
California clapper rail *Rallus longirostris obsoletus*	E	None designated	Salt and brackish marshes of the San Francisco Bay estuary	Not expected to be affected by the Proposed Action. Interim and Restoration flows effects in the Delta are expected to be so minimal that changes in vegetation communities are not likely to occur

Table 1-2.
Federally Listed Species Eliminated from Further Analysis (contd.)

Species	Federal Status	Critical Habitat	Habitat Association	Rationale
California red-legged frog *Rana aurora draytonii*	T	No designated (71 *Federal Register* 19244–19346, April 13, 2006) or proposed revised designated critical habitat in the Action Area (73 *Federal Register* 53492–53680, September 16, 2008)	Aquatic habitats, such as creeks, streams, and ponds	Unlikely to occur in the San Joaquin, Merced, Stanislaus, and Tuolumne rivers; no longer occurs on the floor of the Central Valley and rare in the foothills
Salt marsh harvest mouse *Reithrodontomys raviventris*	E	None designated	Saline emergent wetlands of San Francisco Bay and its tributaries	Not expected to be affected by the Proposed Action. Effects in the Delta of Interim and Restoration flows are expected to be so minimal that changes in vegetation communities are not likely to occur

Sources: USFWS 2005, 2011
Key:
E = Federally listed as endangered
ssp. = subspecies
T = Federally listed as threatened

1.5 Critical Habitat

Critical habitat is defined in Section 3(5)A of the ESA as the specific areas within the geographical area occupied by the species in which are found physical or biological features essential to the conservation of the species, and areas that may require special management considerations or protection (15 USC 1632A). Specific areas outside the geographical area occupied by the species also may be included in designations of critical habitat, upon a determination that such areas are essential for the conservation of the species.

The Proposed Action addressed in this BA has the potential to adversely affect critical habitat for the following species under NMFS and USFWS jurisdictions: Central Valley steelhead distinct population segment (DPS), Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU), Sacramento River winter-run Chinook salmon ESU, DPS of the North American green sturgeon, delta smelt, succulent owl’s-clover, Hoover’s spurge, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, Green's tuctoria, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, California tiger salamander, and Fresno kangaroo rat.

1.6 Essential Fish Habitat

In response to growing concern about the status of U.S. fisheries, Congress passed the Sustainable Fisheries Act of 1996 (Public Law 104-297) to amend the Magnuson-Stevens Fishery Conservation and Management Act, the primary law governing marine fisheries management in the Federal waters of the United States. The Magnuson-Stevens Fishery Conservation and Management Act, as amended (16 USC 1801), requires that EFH be identified and described in Federal fishery management plans. Federal agencies must consult with NMFS on any activity that they fund, permit, or carry out that may adversely affect EFH. EFH includes habitats on which fish depend throughout their life cycles. It encompasses habitats necessary to allow sufficient production of commercially valuable aquatic species to support a long-term sustainable fishery and contribute to a healthy ecosystem.

The EFH regulations require a Federal agency obligated to consult on EFH to also provide NMFS with a written assessment of the effects of the Federal agency's actions on EFH (50 CFR 600.920). NMFS is required to provide EFH conservation and enhancement recommendations to the Federal agency. The statute also requires the Federal agency to provide a detailed written response to NMFS within 30 days after NMFS' conservation recommendations for EFH are received. The Federal agency's response must detail how the agency intends to avoid, mitigate, or offset the effect of the activity on EFH (Section 305(b)(4)(B)). This BA includes evaluation of EFH for Pacific salmon and Pacific coast groundfish (e.g., starry flounder), which encompasses the Action Area – the San Joaquin River downstream from Friant Dam to and including the south Delta.

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Chapter 2.0
Consultation to Date

Technical assistance, preconsultation, and consultation between Reclamation and NMFS and/or USFWS regarding the SJRRP generally has been regular and ongoing for almost 3 years, primarily as part of the Environmental Compliance Permitting and Work Group (ECPWG), which includes staff from all Implementing Agencies, including Reclamation, NMFS, and USFWS. Table 2-1 lists, in chronological order, the technical assistance, preconsultation and consultations held to date. Major discussion topics, including important guidance or key decisions, are summarized in Table 2-1, including ESA compliance for the Water Year (WY) 2010 and 2011 Interim Flows, the Proposed Action, and the SJRRP as a whole. The ECPWG members continue to meet regularly to discuss ESA issues and daily conference occurs between USFWS and Reclamation as individuals from the SJRRP staff of both agencies are colocated. Although not summarized in Table 2-1, Reclamation, NMFS, USFWS, California Department of Fish and Game (DFG), California Department of Water Resources (DWR), and other regulatory agencies have had weekly calls to discuss streamflow, water quality, and adaptive management updates during the WY 2010 and 2011 Interim Flow releases.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
March 25, 2008	ECPWG meeting	None	Mark Littlefield	Mark Littlefield will seek input from his staff regarding the specific areas in which surveys will need to be completed for specific species before releasing Interim Flows.
April 8, 2008	ECPWG meeting	None	Mark Littlefield	The group discussed the differences in surveys needed to permit Interim and Restoration flows versus those needed to permit the entire program.
June 10, 2008	ECPWG meeting	None	Mark Littlefield	Interim Flows in WY 2010 might require minimal species/habitat surveys, including surveys for the California tiger salamander. The group is assuming that Interim Flows will not use Reach 4B1.
July 23, 2008	ECPWG meeting	None	Mark Littlefield	The current Interim Flows description includes flows to Mendota Pool from October 2009 through September 2010 to be recovered by the San Joaquin River Exchange Contractors. Interim Flows beyond 2010 will be covered through the PEIS/R.

**Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)**

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
July 29, 2008	ESA/CESA meeting	None	Mark Littlefield and Maryann Owens	Some changes have occurred to the 2009–2010 Interim Flows project as a result of discussions with SWRCB. Reclamation needs to apply for temporary change permit with SWRCB. Interim flows would be for the period between October 1, 2009, and September 30, 2010. Interim Flow releases are not expected to reach Mendota Pool. Reclamation's water rights do not include fish and wildlife habitat. Therefore, the purpose of use identified in the rights would need to be changed under Water Code Section 1705 to accommodate this use. Discussion included how more water in Reaches 1 and 2 related to the Interim Flows could affect listed species in Mendota Pool. Giant garter snake may be an issue, but the addition of more water may be beneficial to the species. Maryann Owens inquired about giant garter snake surveys completed approximately 5 years ago. Julie Vance (DFG) will follow up about the availability of these data. The historical occurrence of bank swallow in Mendota Pool is likely not an issue, because habitat has been altered and is no longer suitable for nesting. A question was asked about what the maximum flows were for the pilot study. (They were estimated to be between 600 and 1,000 cfs.) The pilot study received concurrence from USFWS that there would not likely be an adverse effect on Federally listed species. In addition, no take of State-listed species would occur. Julie Vance (DFG) and Maryann Owens (USFWS) think that a similar conclusion may be appropriate for the Interim Flows project, but they need to discuss with John Beam (DFG) the potential water level effects in Mendota Pool before a determination is made.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
October 28, 2008	ECPWG meeting	None	Mark Littlefield and Stephanie Rickabaugh	The group discussed the potential to send Interim Flows in WY 2010 through the Eastside Bypass to the Delta. The compliance associated with this action is expected to require an EIS/R, which would be difficult to complete in the allotted time frame, particularly considering the additional endangered species thought to be present in the bypass (e.g., button celery). For these reasons, and because of uncertainty on the authority to use the bypass, the group recommended restricting Interim Flows to Mendota Pool.
November 4, 2008	ECPWG meeting	None	Mark Littlefield	The team discussed the state of the WY 2010 Interim Flows project description. The team discussed the location of potential habitat for blunt-nosed leopard lizard in Reach 2B because it relates to potential levee setbacks in this reach.
November 18, 2008	ECPWG meeting	None	Stephanie Rickabaugh	The group agreed that if Interim Flows would be delivered to the Delta, the action may no longer be exempt from CEQA and could require an EIS/R, as well as a BO, and would therefore take enough time to affect the schedule. Thus, Interim Flows should not be delivered past the Merced River confluence. The group agreed to include two flow delivery points (wildlife refuges in Reach 5, Mendota Pool) in the EA for coverage for environmental review and permitting.
December 2, 2008	ECPWG meeting	None	Stephanie Rickabaugh	Interim Flows were discussed generally.
December 16, 2008	ECPWG meeting	None	Stephanie Rickabaugh	The WY 2010 Interim Flows project description is nearing completion and will be ready for review soon. The current description includes sending flows to the wildlife refuges upstream from the Merced River confluence.
January 6, 2009	ECPWG meeting	None	Stephanie Rickabaugh	Interim Flows were discussed generally.
January 20, 2009	ECPWG meeting	None	Stephanie Rickabaugh	Stephanie Rickabaugh requested spatial inundation information on the WY 2010 Interim Flows, which MWH will provide from MEI. This information will allow a better understanding of the potential to affect special-status species.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
February 3, 2009	ECPWG meeting	None	Stephanie Rickabaugh	Because of potential issues with giant garter snake habitat in the backwater area of Mendota Pool, more discussion is needed in the EA on the potential changes in stage operations at Mendota Pool. Reclamation will look into operations at Mendota Pool to determine whether there is potential active storage available that could result in backwater stage changes. Because of the potential that blunt-nosed leopard lizard habitat exists in the Eastside Bypass, Stephanie Rickabaugh requested better information on the potential inundation at Interim Flow levels. Stephanie stated that a finding of not likely to adversely affect blunt-nosed leopard lizard would require informal consultation with USFWS.
February 17, 2009	ECPWG meeting	None	Stephanie Rickabaugh	Reclamation described the two alternatives to be included in the EA/IS. The two alternatives will be the No-Action Alternative and one action alternative. The action alternative will describe sending flows as far as China Island in Reach 5; however, if there are legal constraints (such as land access) or regulatory constraints (such as discovery of a species fully protected by the State), flows will be delivered to an intermediate point (either the East Bear Creek Unit of the San Luis National Wildlife Refuge Complex or Mendota Pool) to avoid such constraints. Stephanie Rickabaugh and John Battistoni (DFG) will develop the survey protocol for blunt-nosed leopard lizard.
February 19, 2009	Reclamation meeting	Erin Strange and Leslie Mirise	None	Reclamation gave a briefing on the SJRRP to update NMFS on current status. The WY 2010 Interim Flows proposal was discussed, along with the overall SJRRP compliance strategies.
March 3, 2009	ECPWG meeting	None	Stephanie Rickabaugh	Interim Flows were discussed generally.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
March 19, 2009	ESA/CESA meeting	Leslie Mirise	Stephanie Rickabaugh and Maryann Owens	Blunt-nosed leopard lizard survey protocol from USFWS and DFG will be sent to Reclamation next week and will be used to determine the survey effort. It was noted that ESRP mapped elderberry shrubs throughout Reaches 1–5 and surveyed most of the shrubs for exit holes in 2004–2005; however, USFWS typically considers results valid for only 1 year.
March 24, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	Stephanie Rickabaugh and John Battistoni (DFG) have completed the blunt-nosed leopard lizard survey protocols and are awaiting a USFWS signature.
March 25, 2009	Technical assistance letter	None	Ken Sanchez	USFWS issued a letter to Reclamation, which provided survey protocols for blunt-nosed leopard lizard.
April 7, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	Blunt-nosed leopard lizard surveys were discussed.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
April 16, 2009	ESA/CESA meeting	None	Stephanie Rickabaugh	Brad Hubbard (Reclamation) stated that there are issues related to obtaining land access in the bypass channel to survey for blunt-nosed leopard lizards; therefore, DFG and USFWS will meet on April 24, 2009, to discuss the assumption of presence. The Interim Flows BA outline will be sent to NMFS for its review and comment. It was agreed that there will be only one Interim Flows BA, which will discuss terrestrial and aquatic species. Stephanie Rickabaugh would like more information on several species in the EA (e.g., riparian brush rabbit, California tiger salamander, valley elderberry longhorn beetle, San Joaquin kit fox). Stephanie Rickabaugh recommends that Reclamation make an environmental commitment in the Interim Flows BA to complete vegetation base maps. It was decided that the pictures taken during the invasive species surveys would not suffice for the recommended vegetation base map.
April 17, 2009	Reclamation meeting	None	John Engbring and Stephanie Rickabaugh	Special-status species strategy details were discussed, including the strategy for the blunt-nosed leopard lizard ESA/CESA approach for the WY 2010 Interim Flows proposal.
April 21, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	Leslie Mirise stated that NMFS needs to know if the Hills Ferry Barrier can withstand the expected Interim Flows, if the barrier will be replaced in early spring to block steelhead, and if this will be considered a significant effect. One BA that addresses aquatic and terrestrial species for the Interim Flows will be developed by May 15, 2009, and will not address CESA. USFWS recommends that Reclamation make an environmental commitment to perform vegetation base mapping for the Interim Flows. NMFS and USFWS reviewed the draft BA outline.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
April 22, 2009	Interim Flows meeting	Leslie Mirise	Stephanie Rickabaugh	The SJRRP office staff will provide a technical paper regarding expected operational requirements for the Hills Ferry Barrier that was drafted in support of legislation. The EA/IS description of actions related to the Hills Ferry Barrier will be revised based on this paper. Generally, the project description will include no change to the operation of the Hills Ferry Barrier.
May 1, 2009	ESA/CESA meeting	Leslie Mirise	Stephanie Rickabaugh	NMFS confirmed that the Action Area for the WY 2010 Interim Flows BA should extend to the south Delta.
May 4, 2009	ECPWG meeting	None	Stephanie Rickabaugh	General discussion was held on scheduling for environmental documents. Reclamation stated that the Hills Ferry Barrier will not be put in place in spring; however, a monitoring plan will be developed.
May 14, 2009	BA	N/A	N/A	Reclamation submitted the draft WY 2010 Interim Flows Project BA to NMFS and USFWS.
May 15, 2009	BA comments	None	Stephanie Rickabaugh	USFWS issued comments to Reclamation on the draft WY 2010 Interim Flows Project BA.
May 18, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	NMFS, USFWS, and DFG provided comments on the draft BA.
May 22, 2009	BA	N/A	N/A	Reclamation submitted the WY 2010 Interim Flows Project BA to NMFS and USFWS to initiate Section 7 consultation on the WY 2010 Interim Flows Project.
June 2, 2009	ECPWG meeting	None	Stephanie Rickabaugh	USFWS stated that completion of the Section 7 process will require a final project description (with all public comments incorporated). Formal consultation is underway for geotechnical borings and for WY 2010 Interim Flows. ESRP has begun blunt-nosed leopard lizard surveys in the Eastside Bypass. Reclamation is looking into the possibility of having aerial surveys conducted for baseline vegetation data.

**Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)**

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
June 16, 2009	ECPWG meeting	None	Stephanie Rickabaugh	NMFS is performing a sufficiency review of the BA. USFWS has started analyzing the BA and is considering issuing a concurrence letter instead of a BO, but the final decision has not been made. USFWS stated that modeling development is almost complete for the USFWS 2008 CVP/SWP Operations BO. When it is complete, MWH will complete the modeling runs for the programmatic BA. USFWS stated there was no need for sensitivity analyses with the NMFS 2009 CVP/SWP Operations BO.
June 30, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	USFWS reported that the BA was being routed and that it appeared that the proposed schedule (with the BO complete in September) would be met, assuming no major issues arise. NMFS is working on the sufficiency determination and will be sending out a letter soon requesting more information. No blunt-nosed leopard lizards have been sighted to date in the Eastside Bypass; ESRP staff members are surveying portions of the Mariposa Bypass.
June 30, 2009	ESA/CESA meeting	Leslie Mirise	Stephanie Rickabaugh	Species were identified for which habitat mapping or surveys need to be conducted, including valley elderberry longhorn beetle, blunt-nosed leopard lizard, vernal pool species, and delta button-celery. Valley elderberry longhorn beetle survey protocols and approaches were discussed. The group decided to prepare two separate BAs, due in December 2009, with an annotated outline due on July 21, 2009.
June 30, 2009	Letter of insufficiency	Maria Rea	None	Letter from NMFS requesting additional information on the WY 2010 Interim Flows Project.
July 15, 2009	Letter of concurrence	None	Ken Sanchez	Letter of concurrence from USFWS that WY 2010 Interim Flows Project will not adversely affect USFWS-listed species or adversely modify critical habitat.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
July 16, 2009	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	USFWS has issued a letter of concurrence, contingent upon completing and reporting on the blunt-nosed leopard lizard surveys. Adult blunt-nosed leopard lizard surveys in the Eastside Bypass are continuing and should be completed this week; USFWS and DFG agreed to a 2-day extension on the survey period.
July 23, 2009	Conservation strategy meeting	None	Stephanie Rickabaugh	The group discussed incorporating additional mitigation measures into the conservation strategy.
August 25, 2009	ECPWG meeting	None	Mark Littlefield	The valley elderberry longhorn beetle and blunt-nosed leopard lizard surveys have been completed. The group discussed distributing and reviewing data and reports.
September 15, 2009	ESA/CESA meeting	None	MaryAnn Owens	ESRP is completing surveys for blunt-nosed leopard lizard in the bypasses. The results of preliminary modeling indicate that Interim Flows would not affect this species because the flows would be restricted to the low-flow channel.
September 22, 2009	ECPWG meeting	Leslie Mirise and Elif Fehm-Sullivan	Mark Littlefield	ESRP is to finalize the blunt-nosed leopard lizard survey report and submit it to Reclamation, USFWS, and DFG on September 23, 2009. USFWS anticipates releasing the concurrence letter of not likely to adversely affect for blunt-nosed leopard lizard by September 25, 2009. NMFS anticipates releasing its concurrence letter by September 25, 2009.
September 23, 2009	Letter of concurrence	Rodney McInnis	None	Letter of concurrence from NMFS that WY 2010 Interim Flows Project will not adversely affect NMFS-listed species or adversely modify critical habitat.
September 24, 2009	Letter of concurrence	None	Ken Sanchea	Letter of concurrence from USFWS that WY 2010 Interim Flows Project will not adversely affect blunt-nosed leopard lizard.
October 6, 2009	ECPWG meeting	Leslie Mirise and Elif Fehm-Sullivan	Mark Littlefield and Stephanie Rickabaugh	WY 2010 Interim Flows released on October 1, 2009, reached Gravelly Ford on October 4. Commitments laid out in the EA/IS/MND are being completed/managed by Reclamation and DWR.

**Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)**

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
October 13, 2009	ESA/CESA meeting	Leslie Mirise	Mark Littlefield	USFWS suggested that delta smelt should be evaluated separately in the BA because there may be a need for additional CVP/SWP Operations modeling.
November 3, 2009	ECPWG meeting	Leslie Mirise and Elif Fehm-Sullivan	None	As of November 1, 2009, 700 cfs was released from Friant Dam. This is different from the date listed in the Settlement (October 31) because of the requirements of the SWRCB order. Per NMFS and the SWRCB order requirements, streamflow and water quality meetings are being held weekly. Of the 12 seepage wells, 9 have been installed (on private lands in Reaches 3 and 4), and all 33 monitoring wells on public lands will be installed this week.
December 1, 2009	ECPWG meeting	Leslie Mirise	None	Until February 2010, 120 cfs is being released from Friant Dam. Reclamation and DWR are investigating the need to install additional seepage wells on private lands.
January 14, 2010	ECPWG meeting	Leslie Mirise	Mark Littlefield and Stephanie Rickabaugh	At a meeting in the second week of December 2009, DFG's legal staff determined that the threatened status of spring-run Chinook salmon from the Sacramento watershed applies to those fish (or their progeny) that migrate from the Sacramento River to the San Joaquin River. In addition, draft legislation was proposed to add language to CESA that would allow DFG to make a determination (similar to a Section 2080.1 consistency determination) regarding the experimental population under Section 10(j) of the ESA.
June 15, 2010	BA	N/A	N/A	Reclamation submitted the WY 2011 Interim Flows Project BA to NMFS and USFWS.
June 15, 2010	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	The Friant Dam release was decreased to 350 cfs and will remain at that level for the rest of the water year. The WY 2011 Interim Flows BA is now available for comment through July 9, 2010. HDR is completing the BA, which is expected to be sent to the fisheries agencies today to start the consultation process.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
July 20, 2010	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh and Ellen McBride	Comments on the WY 2011 Interim Flows BA are due by July 23, 2010. NMFS will issue an insufficiency letter. DWR finished blunt-nosed leopard lizard surveys with negative findings. A Section 10(a)1(A) permit will be submitted by the end of September for the fisheries reintroduction process. The permit will include three categories: stock, hatchery, and reintroduction. Each will have a monitoring component.
July 23, 2010	Letter of insufficiency	Maria Rea	N/A	Letter from NMFS requesting additional information on the WY 2011 Interim Flows Project.
September 13, 2010	BA errata	N/A	N/A	Reclamation issued a BA Errata and response to NMFS comments on the WY 2011 Interim Flows BA.
September 28, 2010	Letter of concurrence/ BO	None	Ken Sanchez	Letter of concurrence from USFWS that WY 2011 Interim Flows Project will not adversely affect USFWS-listed species or adversely modify critical habitat and a BO from USFWS addressing the effects of the WY 2011 Interim Flows Project on blunt-nosed leopard lizard.
September 30 2010	Letter of concurrence	Rodney McInnis	N/A	Letter of concurrence from NMFS that WY 2011 Interim Flows Project will not adversely affect NMFS-listed species or adversely modify critical habitat.
October 21, 2010	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	The Section 10(a)1(A) application for fisheries reintroduction was submitted on September 30, 2010, for a 30-day review. The draft programmatic BA is due out in early 2011.
December 2, 2010	Discussion of sensitivity analysis	Leslie Mirise, Rhonda Reed, Erin Strange, Beth Wrege	Stephanie Rickabaugh	An overview of the sensitivity analysis and modeling was presented and discussed with USFWS and NMFS.
January 11, 2011	PEIS/R analysis and BA approach meeting	Leslie Mirise, Rhonda Reed, Erin Strange, Beth Wrege	Stephanie Rickabaugh	Discussion of analysis for tributaries to the San Joaquin River in the PEIS/R and BA. This analysis incorporated comments from the December 2, 2010, meeting, including Instream Flow Incremental Methodology study results for Chinook salmon and steelhead.

Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion
January 21, 2011	WY 2012 discussion	Leslie Mirise, Rhonda Reed, Erin Strange	Stephanie Rickabaugh	Overview and discussion of needs for WY 2012 environmental documents and discussion of what agencies need to make determinations.
January 24, 2011	ECPWG meeting	Leslie Mirise	Stephanie Rickabaugh	Check-in and overview of project- and program-level projects and updates on expectations of documents needing preparation, review, and comment in 2011.
February 15, 2011	ECPWG meeting	Leslie Mirise	Rebecca Lorig	Check-in and overview of project- and program-level projects
June 7, 2011	BA	N/A	N/A	Reclamation submitted the first administrative draft Programmatic BA to NMFS and USFWS.
June 27, 2011	BA comments	N/A	Stephanie Rickabaugh	USFWS issued comments to Reclamation on the first administrative draft Programmatic BA.
July 15, 2011	BA comments	Erin Strange	N/A	NMFS issued additional comments to Reclamation on the first administrative draft Programmatic BA.
July 28, 2011	BA comments	Erin Strange	N/A	NMFS issued comments to Reclamation on the first administrative draft Programmatic BA.
August 2, 2011	Consultation Meeting	Leslie Mirise, Erin Strange, Rhonda Reed, Beth Wrege	None	Discussion on first administrative draft Programmatic BA, including discussion of comments provided by NMFS on first administrative draft Programmatic BA.
September 28, 2011	BA	N/A	N/A	Reclamation submitted the second administrative draft Programmatic BA to NMFS and USFWS.
October 26, 2011	BA comments	Erin Strange	N/A	NMFS issued comments to Reclamation on the second administrative draft Programmatic BA.

**Table 2-1.
Endangered Species Act Technical Assistance, Preconsultation, and Consultation Conducted for the San Joaquin River Restoration Program (contd.)**

Date	Meeting or Coordination	NMFS Personnel Present	USFWS Personnel Present	Important Decisions/Guidance Given/General Discussion

Key:
BA = biological assessment
BO = biological opinion
CEQA = California Environmental Quality Act
CESA = California Endangered Species Act
cfs = cubic feet per second
CVP = Central Valley Project
Delta = Sacramento-San Joaquin Delta
DFG = California Department of Fish and Game
DWR = California Department of Water Resources
EA = environmental assessment
ECPWG = Environmental Compliance and Permitting Working Group
EIS/R = environmental impact statement/report
ESA = Federal Endangered Species Act
ESRP = Endangered Species Recovery Program
IS = initial study
MEI = Mussetter Engineering, Inc.
MND = mitigated negative declaration
MWH = MWH Americas, Inc.
N/A = Not applicable
NMFS = National Marine Fisheries Service
PEIS/R = program environmental impact statement/report
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
SJRRP = San Joaquin River Restoration Program
State = State of California
SWP = State Water Project
SWRCB = State Water Resources Control Board
USFWS = U.S. Fish and Wildlife Service
WY = water year

Chapter 3.0
Description of Proposed Action

This chapter describes the Action Area as well as the Proposed Action considered and evaluated in this BA. As described in Chapter 1.0, “Introduction,” this BA provides program-level analysis for required actions identified in the Settlement, and project-level analysis for the reoperation of Friant Dam and other actions associated with the release and recapture of Interim and Restoration flows using existing facilities. Additional project-level compliance may be required in the future for actions analyzed at a program level in this BA. Both the project- and program-level actions described in this BA reflect a range of potential actions to identify and disclose potential environmental effects. The Proposed Action analyzed in this BA includes the reoperation of Friant Dam, and actions that contribute to the Restoration Goal and the Water Management Goal.

3.1 Description of the Action Area

The Action Area (Figure 1-1) has been broadly defined to evaluate potential direct, indirect, and cumulative effects within four geographic areas:

- **San Joaquin River upstream from Friant Dam.** This area includes Millerton Lake and its watershed and the San Joaquin River between Kerckhoff Dam and Millerton Lake.
- **San Joaquin River from Friant Dam to the Merced River confluence (Restoration Area).** This section of the river is referred to as the Restoration Area, and includes Reaches 1 through 5 and portions of the flood management system (Figure 3-1), and extends approximately 4,000 feet outward along either side of San Joaquin River and the bypasses. All construction actions to support the Restoration Goal would be conducted in this geographic area. Some actions to support the Water Management Goal would be conducted in the Restoration Area.
- **San Joaquin River from the Merced River to the Delta.** Release of Interim and Restoration flows would increase flows in this reach in most years. This reach also would support migration of Chinook salmon between the Delta and the Restoration Area. Some actions to support the Water Management Goal would be conducted in this reach.
- **South Delta.** The south Delta is defined as the San Joaquin River within the Delta west to its confluence with the Sacramento River. Release of Interim and Restoration flows would increase flows into the Delta in most years and generate changes in facilities operations within Central Valley Project (CVP)/State Water Project (SWP) operational parameters, consistent with regulatory and legal

operating requirements in place at the time flows enter the Delta. Some actions to support the Water Management Goal would be conducted in the Delta.

While the Proposed Action would increase the amount of water moving downstream from the south Delta and entering the Pacific Ocean, as well as the quantity and timing of water moving to CVP/SWP water service areas, these changes would be minimal such that effects would not occur to species or habitat outside of the action area as defined above.

3.1.1 Millerton Lake and San Joaquin River Upstream from Friant Dam

The San Joaquin River originates in the Sierra Nevada at an elevation of 12,000 feet above mean sea level (North American Vertical Datum 1988). Millerton Lake, formed by Friant Dam, is the largest reservoir on the San Joaquin River. Millerton Lake is surrounded by low hills, and habitat surrounding the lake is fairly sparse. Inflow consists primarily of flows from the upper San Joaquin River and is influenced by the operation of several upstream hydropower generation projects, including those at Kerckhoff Dam. Millerton Lake typically fills during late spring and early summer, when San Joaquin River flows are high because of snowmelt in the upper watershed. Friant Dam diverts much of the water from the San Joaquin River to contractors within the CVP Friant Division's water service area. Annual water allocations and release schedules are developed with the intent of drawing down reservoir storage to minimum levels by the end of September. The operation of Friant Dam changes storage levels in Millerton Lake, which in turn can influence resources affected by storage conditions and lake levels.

3.1.2 San Joaquin River from Friant Dam to Merced River

SJRRP restoration activities focus on this approximately 150-mile-long reach of the San Joaquin River, termed the Restoration Area. The river and flood bypasses within the Restoration Area are described as a series of physically and operationally distinct reaches, as shown on Figure 3-1, and described below.

Reach 1

Reach 1 begins at Friant Dam and continues approximately 37 miles downstream to Gravelly Ford. Reclamation makes releases from Friant Dam to maintain continuous flows past Gravelly Ford, providing deliveries to riparian water rights holders in Reach 1 under "holding contracts." The reach is divided into two subreaches, 1A and 1B. Reach 1A extends from Friant Dam to State Route (SR) 99. Reach 1B continues from SR 99 to Gravelly Ford. Reach 1 is the principal area identified for future salmon spawning, but has been extensively mined for instream gravel and is limited for sediment supply.

Reach 2

Reach 2 begins at Gravelly Ford and extends approximately 24 miles downstream to the Mendota Pool, continuing the boundary between Fresno and Madera counties. This reach is a meandering, low-gradient channel. Reach 2 is subdivided at the Chowchilla Bypass Bifurcation Structure into two subreaches. Both Reach 2A and Reach 2B are dry in most months. Reach 2A is subject to extensive seepage losses. Reach 2B is a sandy channel with limited conveyance capacity.

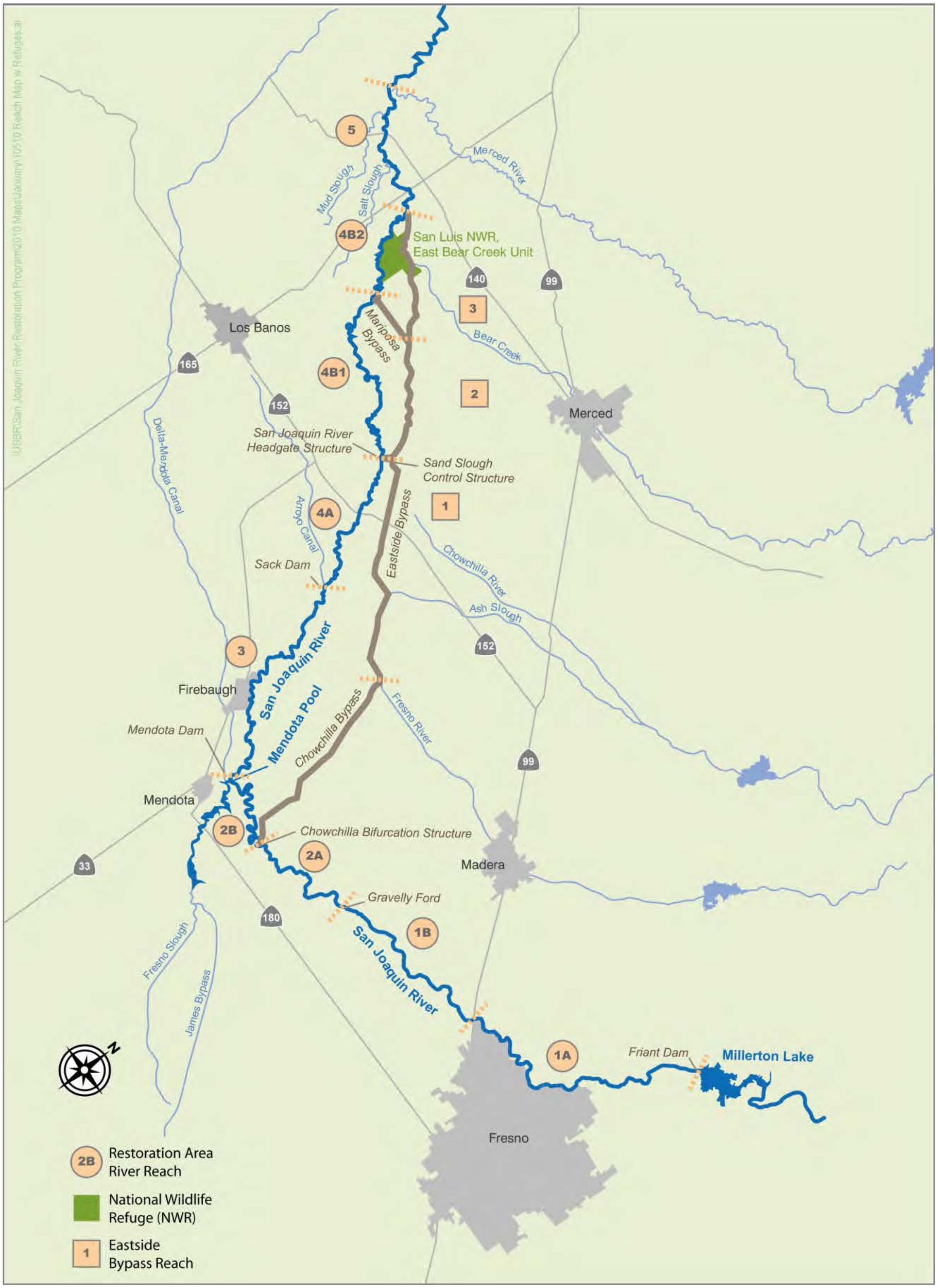


Figure 3-1.
San Joaquin River Reaches and Flood Bypass System in Restoration Area

Reach 3

Reach 3 begins at Mendota Dam and extends approximately 23 miles downstream to Sack Dam. Reach 3 conveys flows of up to 800 cfs from the Mendota Pool for diversion to the Arroyo Canal at Sack Dam, maintaining year-round flow in a meandering channel with a sandy bed. Flood flows from the Kings River are conveyed to Reach 3 via Fresno Slough and Mendota Dam. This reach continues the boundary between Fresno and Madera counties. The sandy channel meanders through a predominantly agricultural area, and diversion structures are common in this reach.

Reach 4

Reach 4 is approximately 46 miles long, and is subdivided into three distinct subreaches. Reach 4A begins at Sack Dam and extends to the Sand Slough Control Structure. This subreach is dry in most months except under flood conditions. Reach 4B1 begins at the San Slough control structure and continues to the confluence of the San Joaquin River and the Mariposa Bypass. All flows reaching the Sand Slough Control Structure are diverted to the flood bypass system via the Sand Slough Bypass, leaving Reach 4B1 perennially dry for more than 40 years, with the exception of agricultural return flows. Reach 4B2 begins at the confluence of the Mariposa Bypass, where flood flows in the bypass system rejoin the mainstem San Joaquin River. Reach 4B2 extends to the confluence of the Eastside Bypass.

Reach 5

Reach 5 of the San Joaquin River extends approximately 18 miles from the confluence of the Eastside Bypass downstream to the Merced River confluence. This reach receives flows from Mud and Salt sloughs, channels that run through both agricultural and wildlife management areas.

Fresno Slough/James Bypass

Fresno Slough, also referred to as the James Bypass, conveys flood flows in some years from the Kings River system in the Tulare Basin to the Mendota Pool. These flows are regulated by Pine Flat Dam.

Chowchilla Bypass

The Chowchilla Bypass Bifurcation Structure at the head of Reach 2B regulates the flow split between the San Joaquin River and the Chowchilla Bypass. The structure is operated depending on flows in the San Joaquin River, flows from the Kings River system via Fresno Slough, water demands in Mendota Pool, and seasonality. The Chowchilla Bypass extends to the confluence of Ash Slough, which marks the beginning of the Eastside Bypass.

Eastside Bypass, Mariposa Bypass, and Tributaries

The Eastside Bypass extends from the confluence of Ash Slough and the Chowchilla Bypass to the confluence with the San Joaquin River at the head of Reach 5. It is subdivided into three reaches. Eastside Bypass Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence, and receives flows from the Chowchilla River. Eastside Bypass Reach 2 extends from the Sand Slough Bypass confluence to the head of the Mariposa Bypass. Eastside Bypass Reach 3 extends from the head of the Mariposa

Bypass to the head of Reach 5, and receives flows from Deadman, Owens, and Bear creeks. Eastside Bypass Reach 3 downstream from the confluence of Bear Creek to its confluence with Reach 5 is alternatively known as Bear Creek. The Mariposa Bypass extends from the Mariposa Bypass Bifurcation Structure to the head of Reach 4B2. A drop structure is located near the downstream end of the Mariposa Bypass that dissipates energy from flows before flows enter the mainstem San Joaquin River.

3.1.3 San Joaquin River from Merced River to the Sacramento-San Joaquin Delta

The San Joaquin River downstream from the Merced River confluence to the Delta receives inflow from several large rivers, including the Merced, Tuolumne, and Stanislaus rivers. These rivers flow west out of the Sierra Nevada Mountains to the San Joaquin River. The Merced, Tuolumne, and Stanislaus rivers each support Central Valley steelhead and fall-run Chinook salmon. The Merced River flows west out of the Sierra Nevada to its confluence with the San Joaquin River at the end of Reach 5. During high-flow events, a portion of Merced River flows is conveyed to the San Joaquin River through Merced Slough. The Tuolumne River flows approximately 150 miles to the San Joaquin River. The Stanislaus River flows into the San Joaquin River just upstream from Vernalis. Several smaller rivers join the San Joaquin River below the Stanislaus River confluence.

3.1.4 Sacramento-San Joaquin Delta

The Delta is a network of islands and channels at the confluence of the Sacramento and San Joaquin rivers. The Delta comprises an area of approximately 750,000 acres, receives runoff from a watershed that includes more than 40 percent of California’s land area, and accounts for approximately 42 percent of the State’s annual runoff (Water Education Foundation 1992). Tributaries that directly discharge into the Delta include the Calaveras, Cosumnes, Mokelumne, Sacramento, and San Joaquin rivers. The Delta supplies water for most of California’s agricultural production and many urban and industrial communities across the State.

In the Delta, the Jones and Banks pumping plants move water from the Delta to a system of canals and reservoirs for agriculture, municipal and industrial (M&I), and environmental uses in the San Joaquin Valley; the San Francisco Bay Area, along the Central Coast; and portions of Southern California. Surface water resources in the Delta are influenced by the interaction of tributary inflows; tides; Delta hydrodynamics; regulatory requirements; and water management actions, such as reservoir releases, in-Delta diversions, and transfers.

The Delta also provides habitat for numerous plant, animal, and fish species, including several threatened or endangered species. The Delta serves as a migration path for all Central Valley anadromous fish in the Central Valley.

3.2 Proposed Action

The Proposed Action includes reoperation of Friant Dam, and a range of actions to achieve the Restoration and Water Management goals, and is equivalent to Alternative A1 described in the Draft PEIS/R (Reclamation and DWR 2011). Under the Proposed Action, Reach 4B1 would convey at least 475 cfs, and the Eastside and Mariposa bypasses would convey any remaining Interim and Restoration flows. The Proposed Action includes the potential for recapture of Interim and Restoration flows in the Restoration Area and in the Delta using existing diversion facilities, and the potential for recirculation of all recaptured Interim and Restoration flows. A Physical Monitoring and Management Plan is included in the Proposed Action to provide guidelines for observing and adjusting to changes in conditions regarding flow, seepage, channel capacity, propagation of native vegetation, and suitability of spawning gravel (see Appendix D of the Draft PEIS/R (Reclamation and DWR 2011) and Section 3.2.3). The Proposed Action also includes a Conservation Strategy (Section 3.2.4) consisting of management actions necessary to provide a net increase in the extent and quality of riparian and wetland habitats in the Restoration Area, to avoid reducing the long-term viability of sensitive species, and to be consistent with adopted conservation plans.

The Proposed Action includes actions analyzed at both a project and program level. The following discussion includes subsections describing the project-level actions (Section 3.3.1) and program-level actions (Section 3.3.2) included in the Proposed Action. Two additional subsections describe the Physical Monitoring and Management Plan (Section 3.3.3) and the Conservation Strategy (Section 3.3.4), which include both project- and program-level actions intended to guide implementation of the Settlement.

3.2.1 Project-Level Actions

The actions analyzed at a project level are described in greater detail below. The Physical Monitoring and Management Plan (see Appendix D of the Draft PEIS/R (Reclamation and DWR 2011)) and the Conservation Strategy, which include both project- and program-level actions, are described in Sections 3.3.3 and 3.3.4, respectively.

Actions analyzed at a **project level** and described in more detail below are as follows:

- **Reoperate Friant Dam and Downstream Flow Control Structures –** Actions for reoperating Friant Dam and downstream flow control structures for the release and conveyance of Interim and Restoration flows include the following:
  - Releasing Interim and Restoration flows from Friant Dam up to the Restoration Flows stipulated by the Settlement, as constrained by then-existing channel capacities
  - Minimizing increases in flood risk in the Restoration Area as a result of Interim and Restoration flows
  - Reoperating downstream flow control structures, which includes modifying operations of the San Joaquin River Flood Control Project (flood management system) and other structures to convey Interim and Restoration flows

  - Establishing an Recovered Water Account (RWA) and managing Friant Dam to make water supplies available to Friant Division long-term contractors at a preestablished rate

- **Recapture Interim and Restoration Flows –** The Proposed Action includes actions to recapture Interim and Restoration flows within the Restoration Area and/or the Delta using existing facilities, as shown in Figure 3-2. Actions to recapture Interim and Restoration flows in the Restoration Area, and Interim and Restoration flows in the Delta, are constrained by established regulatory and institutional conditions, with no new facility construction, facility modifications, or agreements. Recaptured water available for transfer to Friant Division long-term contractors would range from zero to 556 thousand acre-feet (TAF), as shown in Table 3-1. Actions to recapture Interim and Restoration flows under the Proposed Action include the following:

  - Recapture of Interim and Restoration flows in the Restoration Area at Mendota Pool and the East Bear Creek Unit of the San Luis National Wildlife Refuge (NWR) (East Bear Creek Unit)

  - Recapture of Interim and Restoration flows in the Delta at existing CVP/SWP facilities

The following sections describe these project-level actions in greater detail.

Reoperate Friant Dam and Downstream Flow Control Structures

Reoperation of Friant Dam and downstream control structures includes the release of Interim and Restoration flows, reoperating downstream flow control structures, and establishing an RWA, as stipulated by the Settlement and described in the following sections.

Release Interim and Restoration Flows. The release of Interim and Restoration flows from Friant Dam is analyzed at a project level in this BA. Operations at Friant Dam would change to release Interim and Restoration flows to the San Joaquin River, according to the six flow schedules specified in Exhibit B of the Settlement, as shown in Figure 3-3. The flow schedules are specified in Exhibit B of the Settlement according to six year types: Critical-Low, Critical-High, Dry, Normal-Dry, Normal-Wet, and Wet. The total annual unimpaired runoff at Friant Dam for a water year is the index by which the water year type is determined (based on water years 1922 through 2004). The Settlement includes an annual allocation of Interim and Restoration flows using either the Restoration Flow schedules included in Exhibit B of the Settlement, or a more continuous hydrograph, as shown in Figure 3-4, in consideration of recommendations to be made by the RA. Potential alternate pathways for the transformation of allocated Restoration Flows between flow schedules are described in Appendix G of the Draft PEIS/R (Reclamation and DWR 2011). Table 3-2 contains the Settlement-recommended release schedule for Interim and Restoration flows.

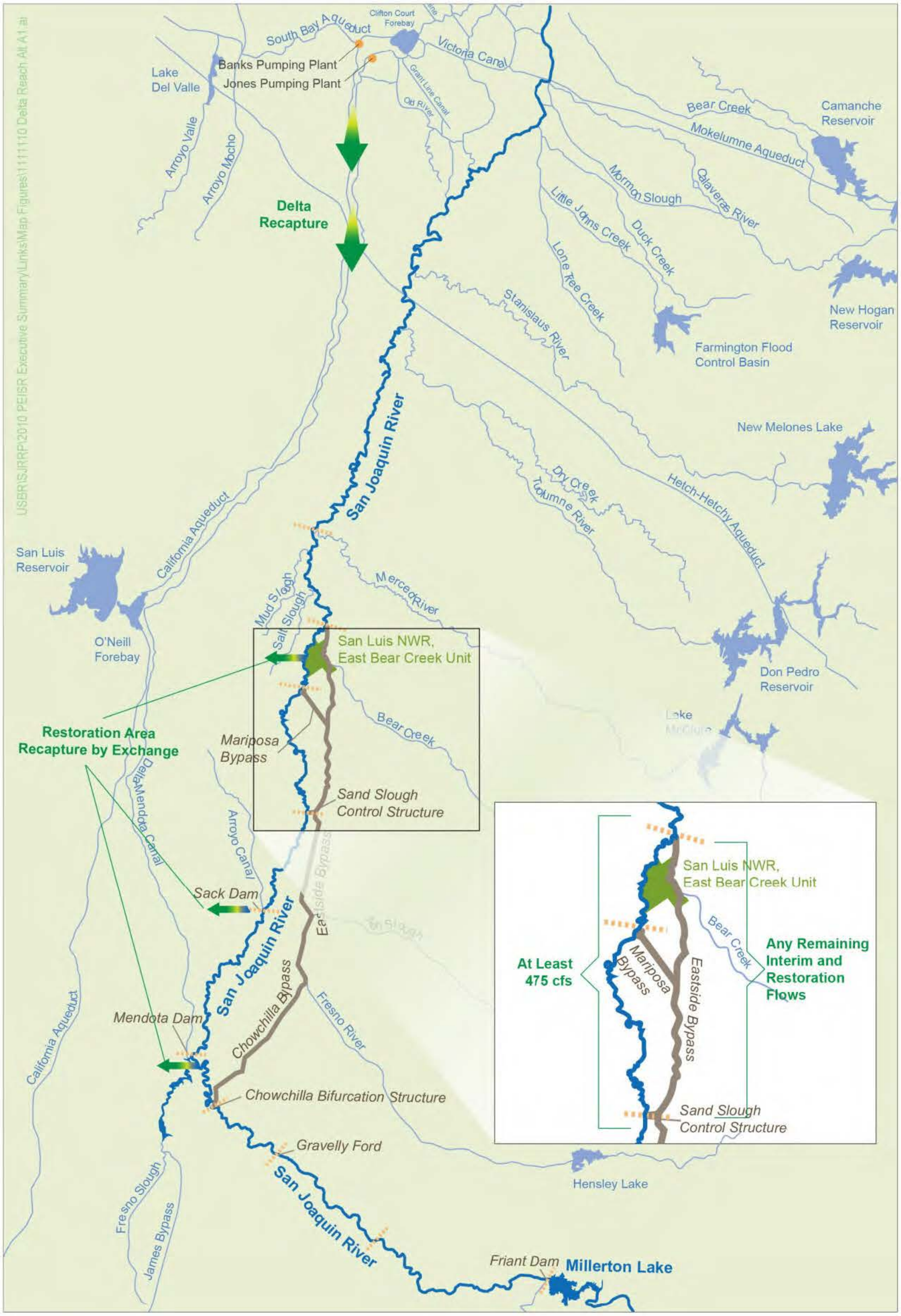


Figure 3-2.
Flow Routing and Water Recapture Under the Proposed Action

Table 3-1.
Estimated Maximum Water Available for Transfer Under the Proposed Action

Begin Date	End Date	Friant Dam Releases According to Settlement		Reach 1 Holding Contract Diversions Estimated as in Exhibit B1	Friant Dam Releases Eligible for Recapture[1]	
		(cfs)	(TAF)	(cfs)	(cfs)	(TAF)
10/1	10/31	350	22	160	190	12
11/1	11/10	700	14	130	570	11
11/11	12/31	350	35	120	230	23
1/1	2/28	350	41	100	250	29
3/1	3/15	500	14	130	370	10
3/16	3/31	1,500	48	130	1,370	43
4/1	4/15	2,500	74	150	2,350	70
4/16	4/30	4,000	119	150	3,850	115
5/1	6/30	2,000	242	190	1,810	219
7/1	8/31	350	43	230	120	15
9/1	9/30	350	21	210	140	8
Total flows released (TAF)			**673**	**Total available for transfer[2] (TAF)**		**556**
Potential buffer flows (TAF)			67	Potential buffer flows (TAF)		67
Potential additional releases pursuant to Paragraph 13(c)			100	Potential additional releases pursuant to Paragraph 13(c), minus seepage[3]		0
Maximum total volume released (TAF)			**840**	**Maximum total volume available for transfer (TAF)**		**623**

Notes:

[1] Under existing conditions, Reclamation makes deliveries to riparian water right holders in Reach 1 under "holding contracts." The amounts in the table are approximate based on recent historical deliveries, as provided in Exhibit B of the Settlement. Water delivered to riparian water right holders would not be eligible for recapture.

[2] Total eligible for recapture is a maximum potential total, and does not account for anticipated losses to seepage or other unanticipated losses.

[3] Paragraph 13(c) requires the acquisition of purchased water to overcome seepage losses not anticipated in Exhibit B. Because these potential releases would only be made to overcome seepage, this water would not be available for transfer.

Key:
cfs = cubic feet per second
TAF = thousand acre-feet

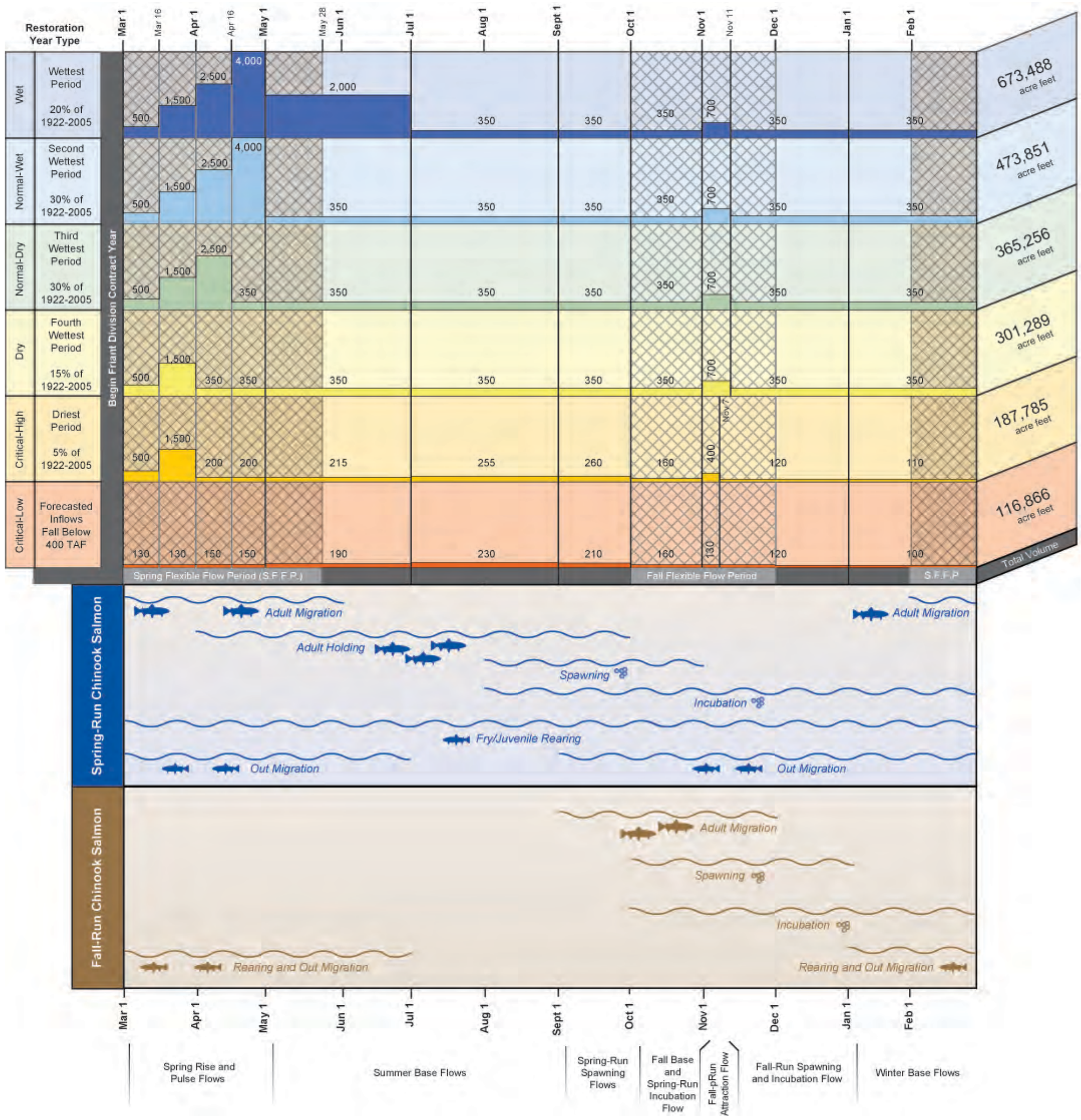
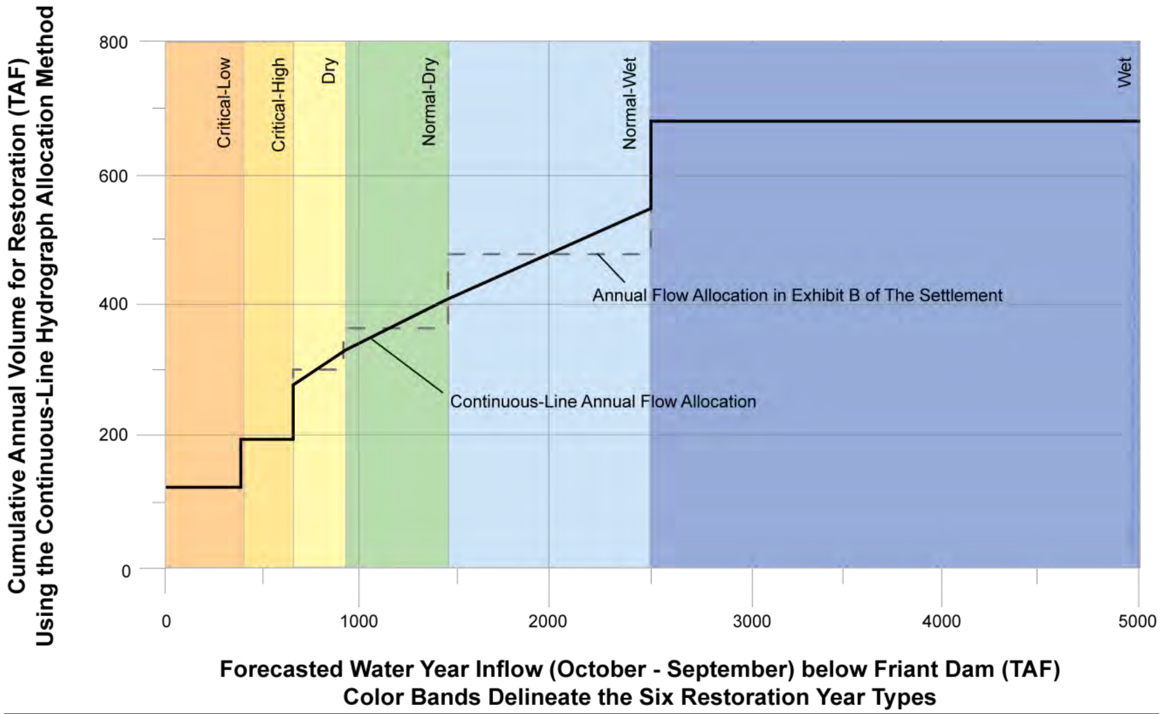


Figure 3-3.
Restoration Flow Schedules Specified in Exhibit B of Settlement



Forecasted Water Year Inflow (October – September) Below Friant Dam (TAF)	Annual Flow Allocation in Exhibit B of Settlement[1] (TAF)	Continuous-Line Annual Flow Allocation (TAF)	Restoration Year Type
Less than 400	116.7	116.9	Critical-Low
Greater than 400 to 670	187.5	187.8	Critical-High
Greater than 670 to 930	300.8	272.3 to 330.3	Dry
Greater than 930 to 1,450	364.6	Greater than 330.3 to 400.3	Normal-Dry
Greater than 1,450 to 2,500	473.0	Greater than 400.3 to 574.4	Normal-Wet
Greater than 2,500	672.3	673.5	Wet

Note:
[1] Friant Dam releases include deliveries to riparian water right holders in Reach 1 under "holding contracts," and releases for the Restoration Goal.

Key:
TAF = thousand acre-feet

Figure 3-4.
Continuous Annual Restoration Flow Allocation

Table 3-2.
Schedule for Release of Interim and Restoration Flows

Year(s)	Days	Release Flows
2009	October 1 through November 20	Of a timing and magnitude, as defined in the appropriate year type release schedule specified in Exhibit B of the Settlement, and without exceeding then-existing channel capacities[1]
2010	February 1 through December 1	Of a timing and magnitude, as defined in the appropriate year type release schedule specified in Exhibit B of the Settlement, and without exceeding then-existing channel capacities[1]
2011 – 2012	February 1 through May 1	Of a timing and magnitude, as defined in the appropriate year type release schedule specified in Exhibit B of the Settlement, and without exceeding then-existing channel capacities
	May 1 through December 1	To wet the channel down to the Chowchilla Bypass Bifurcation Structure to collect information regarding seepage losses[2]
2012 – 2014	January 1 through December 31	Of a timing and magnitude, as defined in the appropriate year type release schedule specified in Exhibit B of the Settlement, and without exceeding then-existing channel capacities or interfering with any remaining in-channel construction activities; continues until modifications identified in Paragraph 11(a) of the Settlement are completed and full Restoration Flows begin
2014 and later	January 1 through December 31	Of a timing and magnitude, as defined in the appropriate year type release schedule specified in Exhibit B of the Settlement, and without exceeding then-existing channel capacities or interfering with any remaining in-channel construction activities

Notes:

[1] Interim Flows during Water Year 2010 (October 1, 2009, through September 30, 2010) are described in the *Water Year 2010 Interim Flows Project Environmental Assessment/Initial Study* released by Reclamation and DWR in September 2009. Interim Flows during Water Year 2011 (October 1, 2010, through September 30, 2011) are described in the *Water Year 2011 Interim Flows Project Supplemental Environmental Assessment* released by Reclamation in September 2010.

[2] This period is intended to correspond to construction activities in Paragraph 11(a). Actual time period of these releases would be coincident with these activities.

Paragraph 15 of the Settlement describes an interim research program that includes the release of Interim Flows beginning in October 2009 and continuing until full Restoration Flows begin (anticipated January 1, 2014), as constrained by then-existing channel capacities. The Restoration Administrator (RA), in consultation with the Technical Advisory Committee, the Secretary, and other appropriate Federal, State, and local agencies, will develop and recommend to the Secretary implementation of a program of Interim Flows. The Interim Flows are intended to allow collection of relevant data concerning flows, temperatures, fish needs, seepage losses, and water recirculation, recapture, and reuse. The Interim Flows include flow releases identified in Exhibit B of the Settlement for the appropriate water year type, including the flexible flow provisions of Exhibit B, to the extent that such releases would not impede or delay completion of actions specified in Paragraph 11(a) of the Settlement, or exceed downstream channel capacities.

The Settlement states that the "Secretary shall commence the Restoration Flows at the earliest possible date…provided, however, that the full Restoration Flows shall commence on a date certain no later than January 1, 2014. If, for any reason, full Restoration Flows are not released in any year beginning January 1, 2014, the Secretary, in consultation with the RA, shall release as much of the Restoration Flows as possible in light of then-existing channel capacity and without delaying completion of the Phase 1 improvements." Paragraph 13(c) of the Settlement identifies procedures to address unexpected seepage losses, including acquiring water or options on water from willing sellers to be utilized for additional releases from Friant Dam.

According to Paragraph 13(i), the RA is responsible for recommending to the Secretary the date for commencing full Restoration Flows in consideration of the completion of Phase 1 improvements (as subsequently described for common Restoration actions). Several Federal and State actions, including channel capacity modifications, are necessary before full Restoration Flows are released. The release of full Restoration Flows is subject to the provisions for flexible flow periods, buffer flows, and purchased water, as well as the provisions described above for Interim Flows. The release and conveyance of full Restoration Flows is defined as meeting Restoration Flow targets at six locations in the Restoration Area identified in Exhibit B of the Settlement, and in consultation with the RA, the six locations are as follows:

- **Friant Dam –** At or immediately below Friant Dam; designated as "Friant Release" in Exhibit B of the Settlement
- **Head of Reach 2A –** At Gravelly Ford; designated as "Reach 2" in Exhibit B of the Settlement
- **Head of Reach 3 –** Immediately below the Chowchilla Bypass Bifurcation Structure; designated as "Reach 3" in Exhibit B of the Settlement
- **Head of Reach 4A –** Downstream from Sack Dam; designated as "Reach 4" in Exhibit B of the Settlement
- **Head of Reach 4B –** Designated as "Reach 5" in Exhibit B of the Settlement
- **Confluence of Merced River –** Designated as "Confluence" in Exhibit B of the Settlement

Flow targets vary by Restoration Year Type, and range from zero cfs (in Reaches 3, 4A, and 4B in Critical-Low years) to 4,055 cfs (at the confluence of the Merced River in Wet and Normal-Wet years) (see Figures 3-3 and 3-4). In some years, the flow targets could be met partially or entirely by flood control releases or by local runoff or return flows.

If, for any reason, full Restoration Flows are not released in any year, beginning January 1, 2014, the Secretary, in consultation with the RA, would bank, store, exchange, transfer, or sell the water through mutually acceptable agreements with Friant Division long-term contractors or third parties (with proceeds deposited into the Restoration Fund established under the Settlement), or release the water from Friant Dam during times of the year other than those specified in the applicable flow schedule. In addition, the Settlement includes provisions for the release of pulse flows in Normal-Wet and Wet Years to perform several geomorphic functions such as flushing spawning gravels, unless the Secretary, in consultation with the RA, determines that such flows are not needed. Flushing flows would be accomplished with a quantity of water based on an average flow of 4,000 cfs from April 16 to 30, and include a peak release as close to 8,000 cfs as possible for several hours, within the constraints of channel capacity. The Settlement also includes the following provisions to modify Restoration Flows, in consideration of recommendations to be made by the RA: application of flexible flow periods, as described in Exhibit B of the Settlement; the use of a 10 percent buffer flow to help meet the Restoration Goal; and the release of acquired water for unanticipated river seepage losses for Restoration Flows.

Reclamation and the San Joaquin River Exchange Contractors have entered into a Second Amended Contract for Exchange of Waters (Contract Ilr-1144) (San Joaquin River Exchange Contract), dated February 14, 1968. Under the terms and conditions of that contract, Reclamation is obligated to make available required deliveries from the Delta-Mendota Canal (DMC) or releases from Millerton Reservoir. If Reclamation makes deliveries to the San Joaquin River Exchange Contractors via the San Joaquin River, these water deliveries would have a higher priority for channel capacity over Interim or Restoration flows. Therefore, Interim and Restoration flows would be reduced, as necessary, to provide channel capacity for water delivery to the San Joaquin River Exchange Contractors via the San Joaquin River. However, it is important to note that under Article 3(n) of the Friant Division long-term water service contracts and the recently executed Friant Division repayment contracts, "The United States agrees that it will not deliver to the Exchange Contractors thereunder waters of the San Joaquin River unless and until required by the terms of said contract, and the United States further agrees that it will not voluntarily and knowingly determine itself unable to deliver to the Exchange Contractors entitled thereto from water that is available or that may become available to it from the Sacramento River and its tributaries or the Sacramento-San Joaquin Delta those quantities required to satisfy the obligations of the United States under said Exchange Contract and under Schedule 2 of the Contract for Purchase of Miller and Lux Water Rights (Contract I1r-1145, dated July 27, 1939)."

Minimize Flood Risk from Interim and Restoration Flows. Throughout Settlement implementation, the maximum downstream extent and rate of Interim and Restoration flows to be released would be limited to then-existing channel capacities. As channel or structure modifications are completed with additional environmental compliance, maximum Interim Flow releases would be correspondingly increased in accordance with then-existing channel capacities and with the release schedule. Consistent with the Act, Interim Flows would be reduced, as needed, to address material seepage impacts, as identified through the monitoring program (see Appendix D of the Draft PEIS/R (Reclamation and DWR 2011)). If release of water from Friant Dam is required for flood control purposes, concurrent Interim and Restoration flows would be reduced by an amount equivalent to the required flood control release. If flood control releases from Friant exceed the concurrent scheduled Interim and Restoration flows, no additional releases above those required for flood control would be made for SJRRP purposes.

Then-existing channel capacities within the Restoration Area correspond to flows that would not significantly increase flood risk from Interim and Restoration flows in the Restoration Area. The action to release Interim and Restoration flows includes measures that would achieve the following objectives: (1) commit Reclamation to implementing actions that would meet performance standards that minimize increases in flood risk as a result of Interim or Restoration flows, (2) limit the release and conveyance of Interim and Restoration flows to those flows that would remain in-channel until adequate data are available to apply the performance standards and until the performance standards are satisfied, and (3) enable the Settlement to be implemented in coordination with other ongoing and future actions outside of the Settlement that could address channel capacity issues identified in the Settlement or through the SJRRP or other programs. Implementation of measures that achieve these objectives would allow for the safe release and conveyance of Interim and Restoration flows throughout the duration of Settlement implementation. Reclamation would implement the following three integrated measures that collectively minimize increases in flood risk as a result of Interim or Restoration flows during Settlement implementation:

- **Establish a Channel Capacity Advisory Group and Determine and Update Estimates of Then-Existing Channel Capacities as Needed –** The establishment and administration of a Channel Capacity Advisory Group to provide independent review of estimated then-existing channel capacities, monitoring results, and management actions to address vegetation and sediment transport within the system as identified by Reclamation.

- **Maintain Interim and Restoration Flows Below Estimates of Then-Existing Channel Capacities –** The process for limiting Interim and Restoration flows to reduce the risk of levee failure due to underseepage, through-seepage, and associated levee stability issues to less-than-significant levels.

- **Closely Monitor Erosion and Perform Maintenance and/or Reduce Interim and Restoration Flows as Necessary to Avoid Erosion-Related Impacts –** The commitment by Reclamation to implement erosion monitoring and management, including monitoring potential erosion sites, reducing Interim and Restoration flows as necessary, and reporting ongoing results of monitoring and management actions to the Channel Capacity Advisory Group.

Only limited data are currently available on San Joaquin River channel capacities and levee conditions. The levee design criteria developed by U.S. Army Corps of Engineers (USACE) and presented in *Design and Construction of Levees Engineering and Design Manual* (Manual No. 1110-2-1913) (USACE 2000) would be applied throughout the Restoration Area to identify the Interim or Restoration flows that would not cause the "Factor of Safety" to be reduced below 1.4, as calculated using USACE levee criteria shown in Table 3-3. The application of the Factor of Safety of 1.4 is required for federally authorized flood control projects. As defined by USACE (2000), the Factor of Safety is equal to one over the exit gradient, as measured at the toe of the levee.

Table 3-3.
Minimum Factors of Safety - Levee Slope Stability

Type of Slope	Applicable Stability Conditions and Required Factors of Safety			
	End-of-Construction	Long-Term (Steady Seepage)	Rapid Drawdown[a]	Earthquake[b]
New Levees	1.3	1.4	1.0 to 1.2	(see below)
Existing Levees	--	1.4[c]	1.0 to 1.2	(see below)
Other Embankments and Dikes[d]	1.3[e,f]	1.4[c,f]	1.0 to 1.2[f]	(see below)

Source: U.S. Army Corps of Engineers. 2000. Design and Construction of Levees Engineering and Design Manual. Manual No. 1110-2-1913. April. Table 6-1b, page 6-5.

Notes:

[a] Sudden drawdown analyses. F. S. = 1.0 applies to pool levels prior to drawdown for conditions where these water levels are unlikely to persist for long periods preceding drawdown. F. S. = 1.2 applies to pool level, likely to persist for long periods prior to drawdown.

[b] See ER 1110-2-1806 for guidance. An EM for seismic stability analysis is under preparation.

[c] For existing slopes where either sliding or large deformation have occurred previously and back analyses have been performed to establish design shear strengths lower factors of safety may be used. In such cases probabilistic analyses may be useful in supporting the use of lower factors of safety for design.

[d] Includes slopes which are part of cofferdams, retention dikes, stockpiles, navigation channels, breakwater, river banks, and excavation slopes.

[e] Temporary excavated slopes are sometimes designed for only short-term stability with the knowledge that long-term stability is not adequate. In such cases higher factors of safety may be required for end-of-construction to ensure stability during the time the excavation is to remain open. Special care is required in design of temporary slopes, which do not have adequate stability for the long-term (steady seepage) condition.

[f] Lower factors of safety may be appropriate when the consequences of failure in terms of safety, environmental damage and economic losses are small.

Until adequate data are available to determine the Factor of Safety, Reclamation would limit the release of Interim and Restoration flows to those which would remain in-channel. In-channel flows are flows that maintain a water surface elevation at or below the elevation of the landside levee toe (i.e., the base of the levee). When sufficient data are available to determine the Factor of Safety, Reclamation would limit Interim and Restoration flows to levels that would correspond to a Factor of Safety of 1.4 or higher at all times. Observation of levee erosion, seepage, boils, impaired emergency levee access, or other indications of increased flood risk identified through ongoing monitoring at potential erosion sites would indicate that the minimum Factor of Safety is not met and would trigger immediate reductions in Interim and Restoration flows at the site. Such observations would supersede channel capacity estimates, and Interim and Restoration flows would be reduced in areas where these conditions occur. Potential immediate responses to reduce, redirect, or redivert Interim or Restoration flows to reduce flow in downstream reaches are described in Section 3.3.3 below.

Detailed discussion of these three measures to reduce flood risk from the release and conveyance of Interim and Restoration flows is presented below.

Establish a Channel Capacity Advisory Group, and Determine and Update Estimates of Channel Capacities as Needed. In coordination with DWR and prior to releasing Interim Flows in Water Year 2013, Reclamation would establish a Channel Capacity Advisory

Group to provide independent review of then-existing channel capacities estimated by Reclamation in accordance with standard USACE levee performance criteria. The Channel Capacity Advisory Group would be responsible for providing timely independent review of data, analytical methodology, and results used to estimate then-existing channel capacities. The Channel Capacity Advisory Group would be comprised of the following:

- One member from the U.S. Bureau of Reclamation
- One member from the California Department of Water Resources
- One member from the U.S. Army Corps of Engineers
- One member from the Lower San Joaquin Levee District
- One member from the Central Valley Flood Protection Board

Reclamation would prepare a report annually or whenever Reclamation contemplates increasing the upper limit of releases for Interim or Restoration flows, which would include data and methods used to develop estimates of then-existing channel capacities. A draft report would be provided to the Channel Capacity Advisory Group for its review and comment for a period of 60 days. In the event that comments or recommendations are received from the Advisory Group within 60 days, Reclamation would be required to consider and respond to such comments and prepare a final report for distribution to the Channel Capacity Advisory Group within 60 days of the close of the draft report review period. Reclamation would not increase Interim or Restoration flows above the previously determined then-existing channel capacities until 10 days after the final report is prepared and distributed to the Channel Capacity Advisory Group. The first draft report shall be completed within 1 year of signing the PEIS/R Record of Decision. Draft reports would include the data, methods, and estimated channel capacities; flow limits and any maintenance activities; and monitoring efforts and management actions as described in this project description. Draft and final reports would be made available to the public concurrent with their distribution to the Channel Capacity Advisory Group.

Reclamation would convene the Channel Capacity Advisory Group as required until 2030, but may stop earlier, provided that then-existing channel capacities are determined to equal or exceed the maximum proposed Restoration Flows throughout the Restoration Area. If after 2030 then-existing channel capacities decrease such that full Restoration Flows cannot be conveyed, the Channel Capacity Advisory Group would be reconvened and function as described above until such time that the then-existing channel capacities are determined to equal or exceed the full Restoration Flows.

Maintain Interim and Restoration Flows at or Below Estimated Then-Existing Channel Capacities. Until sufficient data are available to determine the Factor of Safety, Reclamation would limit initial Interim and Restoration flow releases to those flows which would remain in-channel, as described below. When sufficient data are available to determine the Factor of Safety, Reclamation would limit the release of Interim and Restoration Flows to those flows which would maintain standard USACE levee performance criteria (i.e., a Factor of Safety of at least 1.4) at all times.

In coordination with DWR, Reclamation would apply standard USACE levee performance criteria for levees under a steady state of saturation and consider past performance and hydrologic and hydraulic modeling to determine and update estimates of channel capacities. The resulting estimated channel capacities would be used to establish limits for Interim and Restoration flows throughout the Restoration Area. Reclamation would be required to provide this estimate to the Channel Capacity Advisory Group for review, as previously described.

In the event that insufficient information is available to develop an estimate of channel capacities that maintain a minimum Factor of Safety for levees under saturated conditions by Water Year 2013, Reclamation would limit initial Interim and Restoration flows to those flows which would remain in-channel, as determined by DWR using one-dimensional HEC-RAS hydraulic modeling and described in Appendix I of the Draft PEIS/R (Reclamation and DWR 2011). In-channel flows would have less-than-significant effects on flood risk as explained in the PEIS/R impact assessment of in-channel flows.

Factors of Safety are inversely related to the exit gradient, and describe the potential for unsafe conditions to occur. The exit gradient is the hydraulic gradient at which water leaves the soil surface under saturated conditions, and is a function of both structural design and hydrogeologic conditions. At a critical exit gradient, soil particles may move with water, resulting in unsafe conditions such as piping and boils (Craig 1997, USACE 2000). USACE recommends a Factor of Safety of 1.4 or greater for levees under a steady state of saturation for a prolonged time, such as occurs during flood conditions or with prolonged flows. Maintaining the USACE levee performance criteria for levees under a steady state of saturation would be the key levee performance criterion for maintaining flood risks at less-than-significant levels.

Systematic levee condition monitoring would be implemented as described in more detail in Appendix D of the Draft PEIS/R (Reclamation and DWR 2011). Observation of seepage or boils at the landside levee toe or evidence of levee erosion would indicate that the minimum Factor of Safety is not met. Such observations would supersede channel capacity estimates, and Interim and Restoration flows would be immediately reduced, redirected, or diverted in areas where these conditions occur.

Closely Monitor Erosion and Perform Maintenance and/or Reduce Interim or Restoration Flows as Necessary to Avoid Erosion-Related Impacts. As part of the draft reports prepared by Reclamation and submitted to the Channel Capacity Advisory Group (as described previously), Reclamation would describe the monitoring and management actions taken within the Restoration Area over the prior year and the monitoring and management actions planned for the following year. The draft reports would identify those monitoring and management actions that are a result of implementing the Settlement and those that are a result of regular operations and maintenance and capital improvements to flood control facilities of the Lower San Joaquin River Flood Control Project. The draft reports would be submitted to the Channel Capacity Advisory Group for review as previously described.

Reclamation would implement the flood-related monitoring and management actions included in the project description and in the draft reports to the Channel Capacity Advisory Group, and would work with the appropriate agency(ies) to implement these actions to meet the performance standards as previously described. As previously described, systematic levee condition monitoring would be implemented as described in more detail in Appendix D of the Draft PEIS/R (Reclamation and DWR 2011), and could lead to the immediate reduction of Interim or Restoration flows in areas where these conditions occur.

Erosion monitoring would be conducted by Reclamation using several standard methodologies and protocols commonly employed by DWR, reclamation districts, and/or USACE to monitor levee erosion. Aerial photography and/or ground surveys would be compared to identify changes in bank line over time, indicating potential erosion. True color aerial photographs would be inspected and compared to previous aerial photographs to identify areas of sediment mobilization, bar formation, and bank erosion. After these areas have been initially identified using aerial photography, they would be visited and inspected. If inspections indicate that erosion-related impacts exist or are imminent, management actions would be taken to address the issue.

Field surveys of potential erosion sites on the San Joaquin River between Friant Dam and the Merced River confluence would be conducted by Reclamation annually. These surveys would assess the condition of potential erosion sites, and could include a variety of techniques such as aerial photography and topographic surveys. Previous information documents the existing sediment and geomorphology conditions within the Restoration Area. Existing information developed by Reclamation includes preliminary analyses conducted to identify locations susceptible to potential erosion through comparison of present-day channel positions (2004) and historical channel positions (1937, 1938). Reclamation identified areas that may be susceptible to future erosion using the following criteria:

- Areas of channel change between 1937 and 2004 or between 1983 and 2004 where the channel has shown lateral erosion along an outer bend or where it has the potential to reoccupy an old channel position and laterally erode banks along an outer bend, and that also have low topography (for instance, several outer bends in Reach 1A are located adjacent to high bluffs, which would be considered an area of slower erosion and are thus not identified).
- Meander necks where channel sinuosity is high and could create a cutoff.
- Areas along outer bends where excavated gravel pits are located close to the active channel, regardless of whether any historical channel change has occurred.
- Areas along outer bends that are located adjacent to developed areas (such as at Firebaugh).
- Areas with the potential for future erosion identified through this process and prioritized for monitoring based on potential impacts to infrastructure. The

highest priorities were those with residential developments, buildings, and bridges. Other high-priority areas included those containing levees, irrigation canals, and roads with an apparent high potential to experience some lateral migration or bank erosion.

Sediment mobilization monitoring during these annual surveys would focus on specific potential erosion sites identified through this process, and would evaluate current and potential future erosion at these sites. Channel bed deposition would be evaluated as necessary by analyzing changes identified in topographic survey data and Light Detecting and Ranging (LIDAR) surveys.

The Lower San Joaquin Levee District (LSJLD) and the Central Valley Flood Protection Board (CVFPB) currently have responsibility for implementing routine operations and maintenance or capital improvements to the Lower San Joaquin River Flood Control Project.

Erosion management actions identified through monitoring as described above may fall under the routine maintenance of the Lower San Joaquin River Flood Control Project currently performed by LSJLD. If increased maintenance activities and costs are required as a result of implementing the Settlement, including additional erosion management actions identified through the monitoring activities described in this section, Reclamation would conduct or enter into an agreement with others to conduct such additional maintenance activities. Currently, Reclamation is working with LSJLD to develop and implement an agreement to provide financial assistance for additional costs incurred by LSJLD. The financial assistance agreement is intended to assist LSJLD in adapting to changes in operations and maintenance activities, as needed to maintain the existing level of flood management under release of Interim and Restoration flows.

Reoperate Downstream Flow Control Structures. In addition to management of Interim and Restoration flows at Friant Dam, the Proposed Action includes modifications to the existing operation of the Lower San Joaquin River Flood Control Project (flood management system) and the Hills Ferry Barrier, but without physical, construction-related activities to modify the channels, to address the following:

- **Reoperate Chowchilla Bypass Bifurcation Structure to convey Restoration Flows into Reach 2B –** Currently, the structure is operated as part of the flood management system to direct flood flows and irrigation deliveries based on several factors, including flows in Reach 2A, the capacity of Reach 2B, flows from the Kings River system via Fresno Slough, and water demands in the Mendota Pool. Modifications to the operating criteria would incorporate the routing of Interim and Restoration flows during nonflood operations to meet flow targets in Reach 2B. If flood releases are made from Friant Dam in excess of the Interim or Restoration flows called for, Interim and Restoration flows would not be released and standard operation of the flood management system would apply. Interim and Restoration flows would have a lower priority for downstream channel capacity than flood flows or irrigation deliveries to the San Joaquin River Exchange Contractors.

- **Reoperate San Joaquin River Headgate Structure to convey Restoration Flows into Reach 4B1 –** The current conveyance capacity of Reach 4B1 is unknown and could be as low as zero in some locations. Currently, the San Joaquin River Headgate Structure, part of the flood management system, is maintained in a closed position whereby all flows in the river are routed into the bypass system. The San Joaquin River Headgate Structure would be operated to release Interim and Restoration flows to Reach 4B1 after completion of both modifications to Reach 4B1 (to provide for increased capacity) and to the headgate structure are completed. These releases would be limited by then-existing channel capacity in Reach 4B1.

- **Reoperate the Eastside and Mariposa bypass bifurcation structures to convey Interim and Restoration flows into Reach 4B2 –** Modifications to the operating criteria for these structures, which are part of the flood management system, would include the routing Interim and Restoration flows to the Eastside or Mariposa bypasses. Interim and Restoration flows would have a lower priority for downstream channel capacity than flood flows.

- **Operate and monitor Hills Ferry Barrier –** The main purpose of the Hills Ferry Barrier is to redirect upstream-migrating adult fall-run Chinook salmon into suitable spawning habitat in the Merced River and prevent migration into the main stem San Joaquin River upstream, where conditions are currently considered unsuitable for Chinook salmon and Central Valley steelhead. The peak adult Central Valley steelhead migration period overlaps with that of fall-run Chinook salmon, with most migration occurring between October and December in the San Joaquin River basin, though may continue into February, based on the migration timing of steelhead in the Sacramento River system. Because their body type is similar to salmon, Central Valley steelhead would be expected to be redirected by the barrier in a similarly effective manner. Operations and maintenance of the Hills Ferry Barrier would continue for the purpose of redirecting Chinook salmon and, incidentally, Central Valley steelhead until sufficient habitat and channel improvements to support salmonids are complete, and Reclamation would continue to implement and adapt the *Central Valley Steelhead (Oncorhynchus mykiss) Monitoring Plan for the San Joaquin River Restoration Program* (Reclamation, 2011) (Steelhead Monitoring Plan; Appendix C), in coordination with NMFS. Under the Steelhead Monitoring Plan, the presence of steelhead upstream from Hills Ferry Barrier is monitored. If steelhead are observed, they would be captured and relocated downstream from the Merced river confluence. The Steelhead Monitoring Plan applies to Interim and Restoration flows but would not be implemented in flood flow conditions.

Establish Recovered Water Account and Program. The release of Interim and Restoration flows would reduce annual water deliveries to Friant Division long-term contractors. Consistent with Paragraph 16(b) of the Settlement, Reclamation would identify delivery reductions to Friant Division long-term contractors associated with the release of Interim and Restoration flows, as part of the RWA stipulated for implementation under Paragraph 16(b). Paragraph 16(b) also provides for the delivery of water during wet hydrologic conditions to Friant Division long-term contractors at a cost of $10 per acre-foot. Implementing Paragraph 16(b) actions could affect the amount of water that is released to the San Joaquin River in excess of Restoration Flow requirements during wet periods. The diversion of water from Friant Dam pursuant to Paragraph 16(b) would be based on the following conditions:

- Water at Friant Dam would be eligible for delivery to Friant Division long-term contractors, pursuant to Paragraph 16(b), in wet hydrologic conditions when water is not needed for Interim and Restoration flows.
- Paragraph 16(b) water would be conveyed through the Friant-Kern and Madera canals only when capacity is available, without impacting requirements to meet existing contract deliveries to Friant Division long-term contractors.
- Potential future demand for Paragraph 16(b) water is based in part on the implementation of actions by Friant Division long-term contractors or other water users to increase surface water conveyance or groundwater recharge capacity.

It is anticipated that Friant Division long-term contractors would be able to accept delivery of some Paragraph 16(b) water using existing water conveyance and storage facilities. Because Paragraph 16(b) water would likely be available predominantly during periods when irrigation demand is limited, it is expected that Friant Division and non-Friant Division water users could develop additional local conveyance and storage capacity to increase their ability to receive Paragraph 16(b) water supplies. The Proposed Action is evaluated in consideration of the range of potential changes in water diversions that could result from implementing water facility improvements in the Friant Division to increase delivery capability. Facility improvements to increase delivery capability would require separate environmental compliance documentation, and are not included as actions under the Proposed Action. Pursuant to Part III of the Omnibus Public Land Management Act of 2009 (Public Law 111-11), the Secretary is developing proposed guidelines for projects designed to reduce, avoid, or offset the quantity of expected water supply impacts to Friant Division long-term contractors caused by Interim and Restoration flows. This process is occurring parallel to and separate from development of this BA.

Reclamation is currently working with the Friant Division long-term contractors and appropriate agencies to develop procedures for identifying delivery reductions to Friant Division long-term contractors associated with the release of Interim and Restoration flows as part of the RWA stipulated for implementation under Paragraph 16(b).

Recapture Interim and Restoration Flows

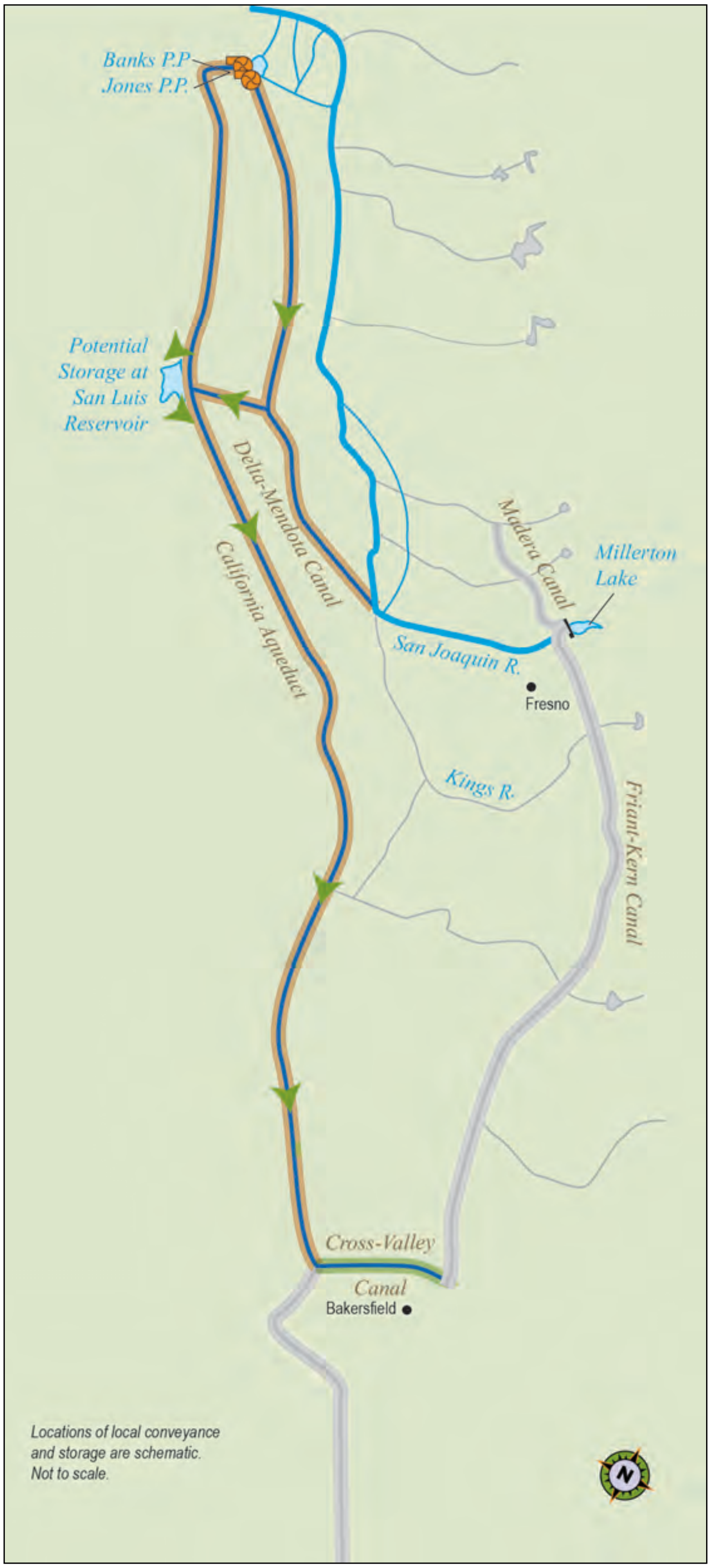
Water recapture actions include recapturing Interim and Restoration flows using existing facilities in the Restoration Area and in the Delta. These actions are analyzed at a project level in this BA. Recaptured water available for transfer to Friant Division long-term contractors would range from zero to 556 TAF, as shown in Table 3-1. Reclamation would identify actual delivery reductions to Friant Division long-term contractors associated with the release of Interim and Restoration flows.

Recapture in the Restoration Area. The Proposed Action includes potential recapture of up to the total quantity of Interim and Restoration flows (556 TAF, as shown in Table 3-1) within the Restoration Area using existing facilities. As previously described, the Settlement includes flow targets in six locations to determine achievement of the Restoration Goal. Paragraph 16(a)(1) of the Settlement provides that recapture and recirculation of Interim and Restoration Flows "shall have no adverse impact on the Restoration Goal, downstream water quality or fisheries." Because recapture within the Restoration Area could prevent the flow targets from being met, recapture within the Restoration Area would occur only if necessary to avoid interfering with in-channel construction activities associated with the Restoration Goal, or to avoid potential material adverse impacts from groundwater seepage (as described in Appendix D of the Draft PEIS/R (Reclamation and DWR 2011)) or for other emergency actions to avoid immediate adverse impacts. Interim and Restoration flows would be recaptured consistent with Federal, State, and local laws, and future agreements with downstream agencies, entities, and landowners. Potential locations within the Restoration Area for recapture of Interim and Restoration flows include the Mendota Pool, and the East Bear Creek Unit located in Eastside Bypass Reach 3. Only diversion facilities that have potential to recirculate Interim and Restoration flows to the Friant Division would be used for recapture locations.

No change in operational requirements would be required to recapture Interim and Restoration flows in the Restoration Area or in the Delta under the regulatory compliance standards in place at the time water is recaptured. In the event that additional operational requirements or changes in operational requirements are implemented at these diversion points, recapture of Interim and Restoration flows would occur within those requirements. Any increase in Restoration Area or Delta exports directly resulting from the Interim or Restoration flows would be available for recirculation to the Friant Division; however, recirculation of recaptured water to the Friant Division could require subsequent exchange agreements between Reclamation, DWR, Friant Division long-term contractors, and other south-of-Delta CVP/SWP contractors who are not included in the Proposed Action. As previously described, recirculation would be subject to available capacity and existing or future operational constraints within CVP/SWP storage and conveyance facilities.

Locations available for recapture of Interim and Restoration flows within the Restoration Area include the following:

- **Recapture at Mendota Pool –** Interim and Restoration flows could be diverted from the Mendota Pool to the extent that these flows would meet demands, replacing CVP water supplies that would otherwise be delivered via the DMC. The DMC carries water from the Delta to the Mendota Pool, where the water is diverted through several existing pumps and canals with a combined capacity that exceeds upstream channel capacity. Interim and Restoration flows diverted by CVP contractors at the Mendota Pool would be in lieu of supplies typically delivered via the DMC. Therefore, CVP water supplies that would have been delivered via the DMC would be made available for delivery to the Friant Division, subject to existing contractual obligations and existing and any future agreements. In such cases, Delta exports would not change compared to existing conditions. Exported water, up to the amount diverted at the Mendota Pool, would be available for recirculation to the Friant Division using existing south-of-Delta facilities, including the Jones Pumping Plant and Banks Pumping Plant, California Aqueduct, DMC, San Luis Reservoir and related pumping facilities, and other facilities operated by CVP/SWP contractors, as shown on Figure 3-5.



Key: P.P. = Pumping Plant

**Figure 3-5.
Major Facilities That May Be Used in Recapture and Recirculation of Interim and Restoration Flows**

- **Recapture at wildlife refuge –** If considerations in Reach 5 or in downstream reaches (such as channel capacity or potential take of listed species that could not be avoided) require that less (or no) flow enters those reaches, Interim and Restoration flows could be diverted to the East Bear Creek Unit in Eastside Bypass Reach 3, to the extent that these flows would meet water supply demands. The East Bear Creek Unit has a pump lift station in the Eastside Bypass with a diversion capacity of 60 cfs. This pump station includes a 48-inch-diameter intake structure and four 125-horsepower electric motors driving 15 cfs pumps. Deliveries of Interim and/or Restoration Flows to the East Bear Creek Unit would be further constrained by actual demand for water supplies at the units. Currently, the East Bear Creek Unit receives CVP water supplies from the DMC.

Recapture in Delta. Interim and Restoration flows reaching the Delta would be recaptured at existing facilities within the Delta consistent with applicable laws, regulations, BOs, and court orders in place at the time the water is recaptured. The Proposed Action includes recapture of Interim and Restoration flows in the Delta at the Jones and Banks pumping plants (Figures 3-2 and 3-5), operated consistent with applicable laws, regulations, BOs, and court orders in place at the time the water is recaptured. Because recapture would occur only as allowable under applicable laws, regulations, BOs, and court orders, any increase in Delta water exports under the Proposed Action would not require or imply a change in export rules. If applicable laws, regulations, BOs, or court orders concerning the operation of existing facilities in the Delta change, the recapture of Interim and Restoration flows would be subject to the new regulations.

3.2.2 Program-Level Actions

Actions analyzed at a program level are described below, and include recirculating recaptured Interim and Restoration flows, and common Restoration actions. The Physical Monitoring and Management Plan (Appendix D of the Draft PEIS/R (Reclamation and DWR 2011)) and the Conservation Strategy, which include both project- and program-level actions, are described in Sections 3.3.3 and 3.3.4, respectively.

Actions analyzed in this BA at a program level and described in more detail below are as follows:

- **Recirculate recaptured Interim and Restoration flows –** The Proposed Action includes recirculating up to the full amount of recaptured Interim and Restoration flows to the Friant Division to minimize water supply impacts to Friant Division long-term contractors caused by Interim and Restoration flows.
- **Common Restoration actions –** Common Restoration actions are potential physical actions to achieve the Restoration Goal, and which would be implemented within the Restoration Area. Figure 3-6 illustrates where various types of common Restoration actions could be implemented within the Restoration Area, and under which part of the Settlement these actions would be implemented. These include actions to modify Reach 4B1 to convey at least 475 cfs of Interim and Restoration flows. Modifications in the Eastside and Mariposa bypasses to convey Interim and Restoration flows in excess of flows routed through Reach 4B1 are described as part of the common Restoration actions.

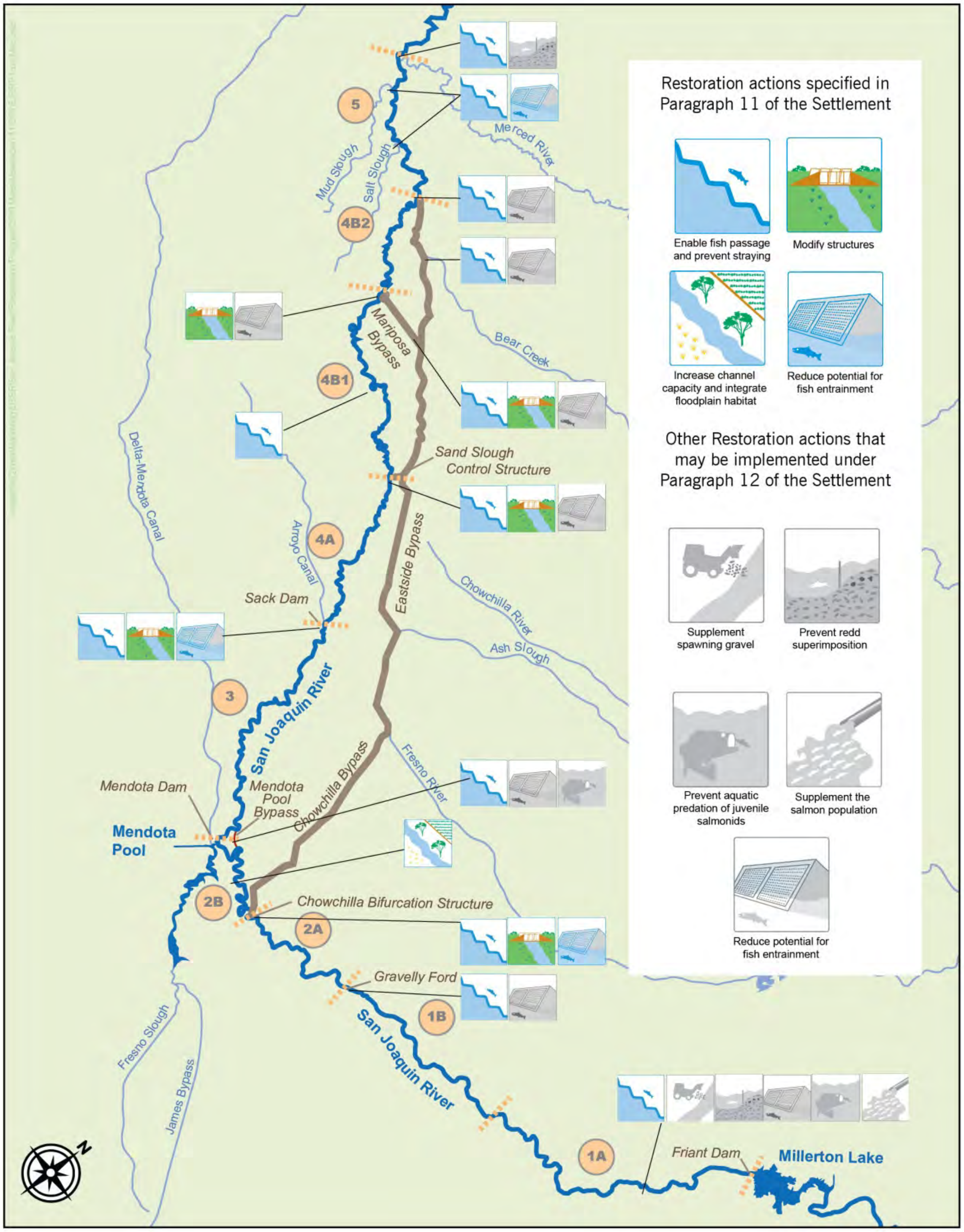


Figure 3-6.
Location of Common Restoration Actions

Recirculate Recaptured Interim and Restoration Flows

Paragraph 16(a) of the Settlement stipulates that the Secretary, in consultation with the Settling Parties, is to develop and implement "…a plan for recirculation, recapture, reuse, exchange, or transfer of the Interim and Restoration flows for the purpose of reducing or avoiding impacts to water deliveries to all of the Friant Division long-term contractors caused by the Interim Flows and Restoration Flows," provided "…that any recirculation, recapture, reuse, exchange or transfer of the Interim and Restoration flows shall have no adverse impact on the Restoration Goal, downstream water quality or fisheries." The quantity of water available for recirculation to the Friant Division long-term contractors would be up to the amount of water recaptured at existing facilities. Water recaptured and recirculated to the Friant Division in this manner could require exchange agreements between Reclamation, DWR, Friant Division long-term contractors, and other south-of-Delta CVP/SWP contractors. The details of the plan for recirculation would be determined through future negotiations between affected parties, and this action is therefore described at a program level in this BA.

Recirculation would be subject to available capacity within CVP/SWP storage and conveyance facilities. Available capacity is capacity that is left after satisfying all statutory and contractual obligations to existing water service or supply contracts, exchange contracts, settlement contracts, transfers, or other agreements involving or intended to benefit CVP/SWP contractors served water through CVP/SWP facilities. No additional agreements would be required to recapture Interim and Restoration flows in the Restoration Area. However, recirculation of recaptured water to the Friant Division could require mutual agreements between Reclamation, DWR, Friant Division long-term contractors, and other south-of-Delta CVP/SWP contractors. Reclamation would develop these agreements in close coordination with Friant Division long-term contractors. Any mutual agreements negotiated to facilitate delivery of water to Friant Division contractors using CVP/SWP facilities would be negotiated so as not to impact CVP/SWP deliveries or operation of the CVP/SWP; such agreements may require additional environmental documentation. In addition, Paragraph 13(i) of the Settlement provides guidance on how to manage any unreleased Restoration Flows starting in 2014, including but not limited options to enter into mutually acceptable agreements with Friant Division long-term contractors or third parties, "…to (A) bank, store, or exchange such water for future use to supplement future Restoration Flows, or (B) transfer or sell such water and deposit the proceeds of such transfer or sale into the Restoration Fund created by this Settlement." Paragraph 13(i) also specifies the release the water from Friant dam during times of the year other than those specified in the applicable hydrograph. Any mutual agreements negotiated to facilitate the actions under Paragraph 13(i) would be negotiated so as not to increase water supply reductions to Friant Division long-term contractors beyond what would have been caused by releases in accordance with the hydrograph releases in Exhibit B of the Settlement. Such agreements may require additional environmental documentation.

Common Restoration Actions

Common Restoration actions require program-level coverage to address cumulative and system-wide effects, and include actions stipulated in Paragraphs 11 and 14 of the Settlement, as well as additional structural or channel improvements that may further enhance the success of achieving the Restoration Goal under Paragraph 12 of the Settlement.

- **Paragraph 11(a).** Common Restoration actions stipulated in Paragraph 11 of the Settlement include channel modifications to be completed in two phases. Phase 1 actions are the 10 actions stipulated in Paragraph 11(a) of the Settlement that are considered the highest priority channel improvements. The Settlement stipulates that those actions be completed by December 31, 2013. Two potential actions require subsequent decisions to determine their necessity: (1) modifications to the San Joaquin River Headgate Structure at the head of Reach 4B1, and (2) modifications in the Eastside and Mariposa bypasses to provide fish passage under low flows. In the following sections, these 10 Phase 1 actions are grouped by common location and/or other linkages, and include the following:

  - **Paragraphs 11(a)(1) and 11(a)(2) –** Construct Mendota Pool Bypass and Modify Reach 2B to convey at least 4,500 cfs

  - **Paragraph 11(a)(3) –** Modify Reach 4B1 to convey at least 475 cfs

  - **Paragraph 11(a)(4) –** Modify San Joaquin River Headgate Structure to enable fish passage

  - **Paragraph 11(a)(5) –** Modify Sand Slough Control Structure to enable fish passage and flow routing

  - **Paragraphs 11(a)(6) and 11(a)(7) –** Screen Arroyo Canal and provide fish passage at Sack Dam

  - **Paragraphs 11(a)(8) and 11(a)(9) –** Modify Eastside and Mariposa bypasses to enable fish passage

  - **Paragraph 11(a)(10) –** Enable deployment of seasonal barriers at Mud and Salt sloughs

- **Paragraph 11(b).** The four Phase 2 actions stipulated in Paragraph 11(b) of the Settlement also are considered high priority channel improvements that may contribute to achieving the Restoration Goal. The Settlement stipulates that these projects be completed by December 31, 2016, in a manner that does not delay completion of Phase 1 actions. Subsequent decisions would be required to determine whether the Phase 2 actions are necessary and, if so, to define the scope of the actions. Phase 2 actions not included in the Proposed Action involve modifications to enable routing of up to 4,500 cfs into and through Reach 4B1

(Paragraphs 11(b)(1) and 11(b)(4)). The following Phase 2 actions included in the Proposed Action are described in the following sections:

- **Paragraph 11(b)(2) –** Modify Chowchilla Bypass Bifurcation Structure
- **Paragraph 11(b)(3) –** Fill or isolate gravel pits

- **Paragraph 14.** Paragraph 14 of the Settlement stipulates that spring-run and fall-run Chinook salmon reintroduction occur by December 31, 2012.

- **Paragraph 12.** Paragraph 12 states that additional structural or channel improvements that may further enhance the success of achieving the Restoration Goal may be recommended by the RA to the Secretary for implementation. Potential actions under Paragraph 12 are not assigned a date for completion under the Settlement. Site-specific studies and subsequent implementation of future potential Restoration actions under Paragraph 12 of the Settlement would be based on information collected through monitoring, as identified in the Physical Monitoring and Management Plan (Appendix D of the Draft PEIS/R (Reclamation and DWR 2011)), during implementation of Settlement-stipulated actions. Potential Restoration actions pursuant to Paragraph 12 that could be identified by the RA at a future date range from no modifications to the level of implementation described below. Appendix E, "Fisheries Management Plan," of the Draft PEIS/R (Reclamation and DWR 2011) addresses specific actions, including those described below, and evaluates their merits (including uncertainty) in an action routing process. The following potential Paragraph 12 actions included in the Proposed Action are described in the following sections:

  - Enhance Spawning Gravel
  - Reduce Potential for Redd Superimposition and/or Hybridization
  - Supplement Salmon Population
  - Modify Floodplain and Side-Channel Habitat
  - Enhance In-Channel Habitat
  - Reduce Potential for Aquatic Predation of Juvenile Salmonids
  - Reduce Potential for Fish Entrainment
  - Enable Fish Passage
  - Modify Flood Flow Control Structures

The Proposed Action includes the anticipated range of potential implementation for common actions under Paragraphs 11, 14, and 12 of the Settlement, as described below and shown in Figure 3-6. All common Restoration actions would require future, separate project-specific planning studies and National Environmental Policy Act (NEPA) and/or CEQA documentation analyzing the effects of implementation. The details described below for these actions are based on initial engineering concepts and information from the Fishery Management Plan (Appendix E of the Draft PEIS/R). These details are subject to change as additional project-specific information is developed.

Common Restoration actions include modifications to the channel and flow control structures, including levees and other portions of the Lower San Joaquin Flood Control Project. As part of any modifications that could affect operation of the Lower San Joaquin Flood Control Project, the lead agencies would conduct a study to determine needed conveyance modifications, including modifications to levees and other related hydraulic features, to maintain existing levels of flood protection. Channel and facility modifications would be designed to not adversely affect flood conveyance capacity or functionality of existing channels and facilities.

Construct Mendota Pool Bypass and Modify Reach 2B. Paragraph 11(a)(1) of the Settlement stipulates the creation of a bypass channel around the Mendota Pool to convey at least 4,500 cfs from Reach 2B downstream to Reach 3. Paragraph 11(a)(2) of the Settlement stipulates modifications in channel capacity, and incorporation of new floodplain habitat and related riparian habitat, to convey at least 4,500 cfs between the Chowchilla Bypass Bifurcation Structure and new Mendota Pool Bypass. Because the functions of these channels are related, they are described together in this section:

- **Construct Mendota Pool Bypass –** Constructing Mendota Pool Bypass includes building a bypass around the Mendota Pool to convey at least 4,500 cfs from Reach 2B to Reach 3 downstream from Mendota Dam. Riparian habitat in the Mendota Pool Bypass is expected to be similar to new floodplain habitat in Reach 2B. Constructing the Mendota Pool Bypass also includes constructing a bifurcation structure in Reach 2B to convey at least 4,500 cfs to the bypass. The bifurcation structure would include a fish screen or other positive fish barrier to direct fish into the bypass channel and minimize or avoid fish passage from Reach 2B to the Mendota Pool. Additionally, the Mendota Pool Bypass would include one or more grade control structures to control bedform and create stable and suitable habitat conditions for fish in the vicinity.

- **Modify Reach 2B to convey at least 4,500 cfs –** Modifying Reach 2B to convey at least 4,500 cfs includes expanding the capacity of the reach to convey at least 4,500 cfs, with integrated floodplain habitat. New levees would be constructed, potentially along either or both sides of Reach 2B, to create an average floodplain width of between 500 feet and 3,700 feet, an associated levee system width of between 700 feet and 3,900 feet, and levee heights of an average 4 feet to 5 feet, depending on the level of floodplain habitat modifications incorporated. Specific levee alignments and modifications would be determined through a separate, project-specific study that would consider a variety of factors, including, but not limited to, fisheries and other environmental requirements, flood risk reduction, land uses, subsurface conditions, topography, and the condition of existing levees. Because of uncertainty regarding the life history behavior of introduced salmon, modifications to Reach 2B may or may not emphasize floodplain habitat for rearing juvenile Chinook salmon, and any modifications would be determined from results of subsequent site-specific studies.

The San Mateo Road, which crosses the river in Reach 2B, may cause backwater effects and downstream scour, and may act as a barrier to upstream Chinook salmon migration during low flows. Subsequent, project-specific technical studies of this crossing would identify the type of modifications that would be necessary for flow and fish passage.

Depending on the final, constructed channel capacity of Reach 2B above the new Mendota Pool Bypass Bifurcation Structure, simultaneous release of 4,500 cfs Restoration Flows to the Mendota Pool Bypass and delivery of San Joaquin River flows to the Mendota Pool may not be possible. Similarly, because Reach 3 is anticipated to have a long-term capacity of 4,500 cfs, simultaneous release of 4,500 cfs of Restoration Flows to the Mendota Pool Bypass and conveyance of flood flows from the James Bypass would not be possible. The Secretary would prioritize flood control and water right delivery obligations over meeting flow targets for Restoration Flows, reducing Restoration Flows in these reaches if channel capacity is insufficient to meet conveyance of flood control or water delivery obligations in combination with Restoration Flows.

Modify Reach 4B1 to Convey at Least 475 cfs. Paragraph 11(a)(3) of the Settlement stipulates required channel modifications in Reach 4B to convey at least 475 cfs. The Act (Section 10009(f)(2)(B)) requires that a determination be made on increasing the channel capacity to 4,500 cfs before undertaking any “substantial construction” in Reach 4B1. Therefore, modifications in Reach 4B1 to convey at least 475 cfs would not include substantial construction, such as changes to existing levees in Reach 4B1. Based on preliminary studies, these modifications are anticipated to include removing in-channel vegetation and modifying road crossings within Reach 4B1. Modifying Reach 4B1 could also include modifications to establish a low-flow channel to support fish migration, ranging from a single low-flow channel to a series of terraced channels to convey incremental low flows of up to 475 cfs or more.

Five road crossings are present in Reach 4B1 that could require modification. These include crossings at Washington Road, Turner Island Road, and three unnamed crossings. It is not known if modifications would be required at the Washington Road or Turner Island Road crossings to allow conveyance of at least 475 cfs or to provide fish passage. Currently, all three unnamed crossings are configured with culverts that may be insufficient to convey 475 cfs and/or may present barriers to upstream migrating adult salmon. Modifying Reach 4B1 could include modifying these road crossings to provide flow capacity and fish passage, as necessary. These modifications could include installing culverts, restructuring the channel, and/or constructing clear span bridges. Project-specific technical studies of these crossings would identify the type of modifications that would be necessary for flow and fish passage, and such modifications would be evaluated in subsequent environmental documents, as needed.

Modify San Joaquin River Headgate Structure to Enable Fish Passage and Flow Routing. Paragraph 11(a)(4) stipulates modifications to the San Joaquin River Headgate Structure to enable fish passage and flow routing of between 500 and 4,500 cfs into Reach 4B1. The Settlement stipulates that these modifications are to be made consistent with the decision on whether to route 4,500 cfs through Reach 4B1. These modifications would be made sufficient to convey at least 475 cfs into Reach 4B1. Modifications to this structure are closely related to Restoration actions in Reach 4B1, described previously.

Modify Sand Slough Control Structure to Enable Fish Passage. The Sand Slough Control Structure could present a barrier to upstream migration of adult salmon. Modifications to the Sand Slough Control Structure for fish passage are stipulated in Paragraph 11(a)(5) of the Settlement. Modifying the Sand Slough Control Structure could include modifying the structure for fish passage pursuant to Paragraph 11(a)(5) of the Settlement by removing the existing flume and replacing it with a gated structure. These modifications would be designed to not adversely affect flood conveyance capacity or functionality of the existing structure. Modifications to this structure are closely related to Restoration actions in Reach 4B1, described previously.

Screen Arroyo Canal and Provide Fish Passage at Sack Dam. Paragraph 11(a)(6) of the Settlement stipulates required modifications to Arroyo Canal to prevent entrainment of anadromous fish. Paragraph 11(a)(7) of the Settlement stipulates required modifications at Sack Dam for fish passage. Sack Dam currently provides the water surface elevation necessary for diversion at Arroyo Canal.

Diversions to Arroyo Canal range from zero to 800 cfs, and typically do not exceed 600 cfs. This action could include installing a screening device at the entrance to Arroyo Canal. The screen could be designed to operate with flows of up to 4,500 cfs in the river, while conveying flows into Arroyo Canal, to prevent entrainment of juvenile Chinook salmon in the canal. It also could include constructing a fish ladder at Sack Dam to allow flow and fish passage for a range of flows of up to 4,500 cfs.

Modify Eastside and Mariposa Bypasses to Enable Fish Passage. Paragraph 11(a)(8) of the Settlement stipulates modifications to structures in the Eastside and Mariposa bypass channels to provide anadromous fish passage on an interim basis until completion of Phase 2 actions described below. Paragraph 11(a)(9) of the Settlement stipulates modifications to the Eastside and Mariposa bypass channels to establish a suitable low-flow channel if the Secretary, in consultation with the RA, determines that such modifications are necessary to support anadromous fish migration through these channels. Because the function of the structures and the channel in these bypasses are related, modifications are described together in this section. Potential actions include the following:

- **Modify structures in Eastside and Mariposa bypasses to provide fish passage –**The Mariposa Bypass Bifurcation Structure at the head of the Mariposa Bypass would be modified to allow fish passage for a range of flows of up to 4,500 cfs. The Mariposa Bypass Drop Structure, at the downstream end of the Mariposa Bypass, presents a barrier to fish passage. Modifying the Mariposa

Bypass Drop Structure could include constructing a fish ladder to allow upstream and downstream fish passage for a range of flows of up to 4,500 cfs, or removing the structure. Modifications would allow the structure to handle 8,500 cfs while not increasing upstream water levels from existing conditions.

- **Modify Eastside and Mariposa bypasses to provide fish passage under low flows –** The Eastside and Mariposa bypass channels were constructed with flat channel bottoms. Although scouring flows since construction have incised low-flow channels in some areas of the bypasses, some areas may not be passable by fish during low flows. The range of potential actions to provide fish passage under low flows could include no modifications, modifications to develop a single low-flow channel to convey at least 475 cfs, and a series of terraced channels to convey incremental low flows of up to 475 cfs.

Enable Deployment of Seasonal Barriers at Mud and Salt Sloughs. Potential false migration pathways to migrating adult salmon may be present in Mud and Salt sloughs, tributaries to Reach 5. Modifications to Mud and Salt sloughs would be made to enable the deployment of barriers on these sloughs to prevent adult salmon from entering these potentially false migration pathways, consistent with Paragraph 11(a)(10) of the settlement.

Modify Chowchilla Bypass Bifurcation Structure. Paragraph 11(b)(2) of the Settlement stipulates modifications to the Chowchilla Bypass Bifurcation Structure to provide fish passage and prevent fish entrainment, if such modifications are necessary to achieve the Restoration Goal, as determined by the Secretary in consultation with the RA, and with the concurrence of NMFS and USFWS. Gaps between the gates of the Chowchilla Bypass Bifurcation Structure allow some flow to leak through the gates, when closed. The gaps may be large enough to allow fish to pass through into the bypass, leaving them stranded. To address potential stranding of fish in the Chowchilla Bypass, modifying the Chowchilla Bypass Bifurcation Structure could include a range of potential actions, such as no modifications, monitoring and management of fish stranding under flood conditions, ranges of flows for screening the Chowchilla Bypass to prevent fish from entering the bypass, retrofitting the gates to prevent fish from passing through gaps between the closed gates, and/or adding an additional, screened gate to the structure. Modifications to this structure would be designed to not adversely affect the flood conveyance capacity or functionality of the existing structure.

Fill or Isolate Gravel Pits. Paragraph 11(b)(3) of the Settlement stipulates filling and/or isolating the highest priority gravel pits in Reach 1, based on their relative potential for reducing juvenile salmon mortality, as determined by the Secretary in consultation with the RA. Gravel pits could contribute to juvenile salmon mortality through effects on water temperatures and by providing habitat for predator species such as largemouth bass. A project-specific technical study would be necessary to identify the highest priority pits; therefore, this action has a potential range of actions, including no modifications, filling or isolating some or all pits, and regrading the floodplain to fill pits. Modifications to gravel pits could be implemented in connection with other potential Restoration actions described later in this chapter.

Chinook Salmon Reintroduction. Paragraph 14 of the Settlement addresses reintroducing spring-run and fall-run Chinook salmon between Friant Dam and the confluence of the San Joaquin River with the Merced River by December 31, 2012. Paragraph 14 states that, in the event that competition, inadequate spatial or temporal segregation, or other factors beyond the control of the Settling Parties make restoring spring-run and fall-run Chinook salmon infeasible, "…then priority shall be given to restoring self-sustaining populations of wild spring run Chinook salmon." The Secretary, through USFWS, and in consultation with the Secretary of Commerce, DFG, and the RA, will reintroduce spring- and fall-run Chinook salmon "at the earliest practical date after commencement of sufficient flows and the issuance of necessary permits." To help facilitate reintroduction of salmon, a management plan has been developed to help guide implementation of Restoration actions. The range of potential actions for Chinook salmon reintroduction spans from reintroducing only spring-run Chinook salmon to reintroducing both spring-run and fall-run Chinook salmon, and could include one or more life stages. Broodstocks would be identified through subsequent studies, and because of the uncertainty associated with broodstock life history, behavioral, and adaptive traits of potential broodstock in the Central Valley, it is most likely that broodstocks would be acquired from a variety of watersheds.

The range of potential actions for Chinook salmon reintroduction could also include the use of the existing San Joaquin Hatchery, another existing hatchery, or a new conservation facility. Although the design and capacity of a new conservation facility would be determined in part by management plans, a new conservation facility could potentially provide for initial reintroduction of spring-run Chinook salmon, fall-run Chinook salmon, and/or other native fish. Hatchery or conservation facility use would be used to supplement the wild population until the fish population is reestablished, at which time the conservation facility would be phased out of use. The Restoration Goal and Paragraph 14 of the Settlement emphasize the need to restore self-sustaining fish populations. Therefore, hatchery of conservation facility populations alone would not fulfill the Restoration Goal, and naturally reproduced individuals would need to be distinguished from hatchery- or conservation facility-produced individuals.

This BA identifies potential system effects associated with reintroducing Chinook salmon. USFWS submitted a 10(a)(1)(a) Enhancement of Species Permit application to NMFS on September 30, 2010, for introducing an experimental population of spring-run Chinook salmon, consistent with the schedule identified in the Settlement. NMFS is required by the Settlement to issue a decision on the permit application for the reintroduction of spring-run Chinook salmon no later than April 30, 2012. Specific environmental effects related to the reintroduction of spring-run Chinook salmon would be addressed in the subsequent project-specific NEPA analysis, and possibly CEQA analysis, in compliance with an associated Special Rule authorizing the experimental population.

Enhance Spawning Gravel. Adult Chinook salmon require suitable gravels, refuge, water depths, and velocities for spawning. The range of potential actions to provide for adequate spawning gravel could include no modifications, augmenting and/or conditioning gravel at existing riffles, or establishing new riffles, as described below:

- **No modifications –** No actions would be taken to modify, augment, or condition gravel either at existing riffles or through establishing new riffles.
- **Augment existing riffles –** This action consists of augmenting existing riffles with clean, spawning-sized gravel at some, or a portion of, the existing spawning areas in Reach 1.
- **Establish new riffles –** This action consists of establishing new riffles to increase and enhance salmonid spawning habitat in Reach 1.

Reduce Potential for Redd Superimposition and/or Hybridization. Spring-run Chinook salmon typically spawn earlier than fall-run Chinook salmon, creating the potential for redd superimposition, when fall-run Chinook salmon construct their redds on top of spring-run redds and dislodge or smother some of the spring-run eggs. In addition, a small percentage of fall-run Chinook salmon may spawn at the same time and location as spring-run Chinook salmon; therefore, potential may exist for hybridization. Hybridization may result in fish with migratory behaviors that are not viable in the San Joaquin River basin. The range of potential actions to reduce redd superimposition or hybridization includes no modifications, the deployment of seasonal barriers, and separate runs of salmon, and also could include potential operation and monitoring of the Hills Ferry Barrier on a seasonal basis.

The ability to control run timing via additional structures to separate spring- and fall-run Chinook salmon, as well as the ability to manage flows to prevent run overlap and hybridization, is unknown. The location and design of barriers has yet to be determined; evaluation of spawning and holding habitat availability and quality would likely guide this decision and is underway.

Supplement Salmon Population. Additional actions not identified in the Settlement could be necessary to supplement the naturally reproducing population, particularly in the years immediately following salmon reintroduction. The Settlement does not stipulate any actions to supplement the salmon population; therefore, a subsequent decision would be required before any such actions could be implemented. The range of potential actions to supplement the Chinook salmon population could include no supplementation, the release of hatchery fish to supplement the natural population for monitoring and management of the natural population, and/or release of hatchery fish to supplement the natural population when natural production is low. These actions are described in greater detail below. Subsequent studies would identify stock for hatchery populations and, as described for salmon reintroduction according to Paragraph 14 of the Settlement, stock for hatchery populations would likely come from a Central Valley population with behavioral and life history characteristics compatible with anticipated conditions on the San Joaquin River. As previously discussed, hatchery populations alone would not fulfill the Restoration Goal, and naturally reproduced individuals would need to be distinguished from hatchery-produced individuals.

- **No supplementation –** No actions would be undertaken to release fish into the San Joaquin River.

- **Release of hatchery salmon to supplement the natural population for monitoring and management –** This action consists of releasing study fish to support evaluations during implementation and monitoring, as needed.

- **Release of hatchery salmon to supplement the natural population for survival –** This action could consist of using hatchery fish to supplement the population in years when monitoring determines that the natural production of juvenile salmon is too low. This could occur during the relatively dry water year types (e.g., Settlement Critical-Low, Critical-High year types) when spring flows are either absent or inadequate to sustain Chinook salmon populations.

Modify Floodplain and Side-Channel Habitat. Additional actions not identified in the Settlement could be necessary to modify the floodplain or side-channel habitat beyond Reaches 2B or 4B1. Such modifications could benefit migrating Chinook salmon and other native fishes by providing additional food sources, increased protection from stranding, and other habitat improvements. The range of potential actions to modify floodplain and side-channel habitat outside Reaches 2B and 4B1 could include no modifications; creating and/or enhancing additional floodplain habitat; creating, enhancing, or isolating side channels; and/or reducing sand transport.

- **No modifications –** No modifications would be undertaken to modify the floodplain and side-channel habitat.

- **Create and/or enhance additional floodplain habitat –** This action could consist of creating and/or enhancing additional floodplain habitat outside Reaches 2B and 4B1 (floodplain modifications in these reaches are described previously as actions stipulated by the Settlement) to provide flexibility to accommodate variable life history strategies of future salmon populations, which may vary spatially and temporally. Modifications would be confined within the existing levee alignment. This action also includes floodplain modifications in reaches other than Reach 2B and Reach 4B1 to provide for the maintenance of floodplain vegetation at a level to be determined based on the associated contribution toward achieving the Restoration Goal.

- **Create, enhance, or isolate side channels –** Side channels occur throughout the river, some with perennial connectivity to the main channel, but most with connectivity only under high-flow conditions, as previously described. In some cases, side channels could provide suitable rearing habitat for juvenile Chinook salmon, or serve as holding habitat for adult Chinook salmon, while other side channels may foster conditions that are unsuitable for salmon, including high temperatures and habitat for predatory species such as largemouth bass. Side-channel enhancement activities could include dredging or widening side channels. Side-channel isolation could consist of filling a channel or constructing berms across the mouth of a channel. Additionally, new side channels could be created to provide additional habitat, if necessary. Creation of new side channels could likely be accomplished through dredging new channels or removing sediment blocking the connectivity of former channels.

- **Reduce sand transport –** The quantity of sand in Reaches 1 and 2 may present challenges to channel stability, and the function of hydraulic control structures and road crossings. This sand has the potential to be mobilized by Interim and Restoration flows to lower reaches that do not currently have sediment transport issues. This action would control sources of sand in Reach 1, and transport of sand in downstream river and bypass reaches, to prevent hydraulic and facilities challenges arising from channel migration, aggradation, or degradation. Control of sediment at tributary sources could include settling basins, bed stabilization (such as floodplain widening to reduce sediment transport potential) in areas where the bed is degrading, and bank stabilization in meandering reaches. In-channel sand could be removed by dredging or by constructing instream sediment detention basins, or sand traps, to capture sand. Accumulated sand would need to be removed periodically to maintain the functionality of sand traps. As previously described, portions of Reach 1 may benefit from modifications to gravel quantities and mobility.

Enhance In-Channel Habitat. This action could incorporate channel modifications to provide salmon habitat, including instream cover such as undercut banks, overhanging vegetation, boulders, large wood, surface turbulence, and features providing refuge from predation. The range of potential actions to enhance in-channel habitat could include no modifications, augmenting existing, and/or creating new, in-channel habitat. Enhancing in-channel habitat could also include modifications such as constructing pools, or dredging and grading to develop or maintain more desirable water temperatures. Deep pools remain cooler during warm summer months, and provide refuge from avian and terrestrial predators. Additional assessments would be conducted to identify the potential for groundwater influence on instream temperatures, and whether water temperature requirements may be met under different conditions and/or different timing of flow releases from Friant Dam.

Reduce Potential for Aquatic Predation of Juvenile Salmonids. Additional actions not identified in the Settlement could be necessary to prevent aquatic predation of juvenile salmonids. Additional potential actions to prevent aquatic predation of juvenile salmonids could include capturing and removing nonnative aquatic predatory species.

Reduce Potential for Fish Entrainment. Unscreened and poorly screened small diversions can entrain migrating juvenile fish. The Settlement does not stipulate actions to screen these small diversions. The range of potential actions to prevent fish entrainment at small diversions could include not screening diversions, or installing or modifying screens at small diversions throughout the Restoration Area. The number of screens installed would be determined through future studies, but could be based on the relative impact of individual diversions to fisheries.

Enable Fish Passage. Obstacles to the successful migration of anadromous fish in the Restoration Area could include hydraulic conditions at road crossings; small San Joaquin River tributaries with unsuitable habitat for salmon spawning and rearing; hydraulic conditions in the river channel at low flow; and other physical features within the river. The range of potential actions to enable fish passage beyond the actions stipulated in the Settlement could include no modifications, establishing and/or maintaining low-flow channels, trapping and hauling juveniles and adults, modifying road crossings, and installing barriers to prevent straying.

- **No modifications –** No actions would be undertaken to enable fish passage.
- **Establish and/or maintain low-flow channels –** This action consists of modifying the channel in reaches outside the Eastside and Mariposa bypasses and Reach 4B1 to provide passage during low-flow conditions, as needed. As described above for the action to enhance in-channel habitat through reducing sand transport, establishing and/or maintaining low-flow channels could include bed stabilization in areas where the bed is degrading, and bank stabilization in meandering reaches. Removing in-channel sand to maintain a low-flow channel could be accomplished by dredging or grading. The range of actions described above for modifications to floodplain and side-channel habitat, such as managing invasive vegetation and creating and/or enhancing additional floodplain habitat, could also be applied to establish and/or maintain low-flow channels through bed and bank stabilization.
- **Trap and haul –** It may be necessary to implement a trap-and-haul operation to sustain Chinook salmon within the Restoration Area if protective features are not completed in time to reintroduce fish, if it is determined that entrainment and physical barriers exist that could hinder reintroducing and managing fish populations, or if river connectivity is disrupted (i.e., in critical water years). Implementing a trap-and-haul program could consist of trapping Chinook salmon smolts in upper reaches (likely Reach 1 or Reach 2) to transport smolts to downstream reaches for release, thereby avoiding temporary undesirable habitat conditions (such as high temperatures or discontinuous flow). In addition, implementing a trap-and-haul program could include trapping adult salmon in downstream reaches and transporting them to Reach 1, thereby avoiding temporary undesirable habitat conditions in intermediate reaches. Several trapping mechanisms could be applied under this action, including passive and active capture techniques. Trapped fish could be transported under controlled conditions by truck to suitable habitat areas and released. Trap-and-haul operations are not envisioned as a long-term management strategy, and would only be used as temporary measure if protective features are not completed in time to reintroduce fish, if it is determined that entrainment and physical barriers exist that could hinder reintroducing and managing fish populations, or if river connectivity is disrupted.

- **Modify road crossings –** This action consists of modifying road crossings to provide for fish passage in Reach 1. These crossings could be modified through installing culverts, restructuring the channel, and/or constructing clear span bridges to enable the crossings to be used during Restoration Flows while providing fish passage. Road crossings in Reaches 2B and 4B that pose potential barriers to fish passage are discussed as possible actions to address Settlement Paragraphs 11(a)(2) and 11(a)(3), respectively.

- **Install barriers to prevent straying –** This action could consist of installing temporary or permanent barriers in the channel to prevent fish from straying into tributaries, flood bypasses, or river reaches with undesirable habitat conditions. The primary categories of permanent fish barrier structures are picket barriers, velocity barriers, and vertical drop structures. Tributaries, flood bypasses, and river reaches that could be screened under this action depend in part on the flow-routing decision made consistent with Paragraph 11(b)(1) of the Settlement, but could include, but may not be limited to, Dry and Cottonwood creeks in Reach 1; Deadmans, Bear, and Owens creeks in the Eastside Bypass; the downstream end of Eastside Bypass Reach 2; the downstream end of Reach 4B; and the downstream end of Eastside Bypass Reach 3.

Modify Flood Flow Control Structures. Additional actions not identified in the Settlement could be necessary to improve fish passage and flow conveyance at flood control structures within the Restoration Area, including modifications to the Chowchilla Bypass Bifurcation Structure, Sand Slough Control Structure, and structures in the Eastside and Mariposa bypasses. The range of potential additional actions to modify flood control structures could include no modifications, retrofitting gates at flood control structures to prevent flow loss, and installing grade control structures to address backwater effects of the Chowchilla Bypass Bifurcation Structure.

- **No modifications –** No actions would be undertaken to modify flood flow control structures.

- **Retrofit gates –** As described for the range of actions to address Paragraph 11(b)(2) of the Settlement, gaps between the gates of the Chowchilla Bypass Bifurcation Structure allow some flow to leak through the gates, when closed. Because of the current function of the structure in routing relatively large flows under flood conditions, the small amount of water lost through closed gates at this and other gated flood control structures in the system (including the San Joaquin River Headgates, Eastside Bypass Bifurcation Structure, and Mariposa Bypass Bifurcation Structure) is not a concern under current operations. However, during the release of Interim and Restoration flows, the loss of water from the main stem San Joaquin River through the closed gates to the bypass channel could inhibit success of the Restoration Goal by reducing the amount of water flowing to downstream reaches. Potential actions to address flow loss range from no retrofit implementation to retrofitting the gates on the existing flood control structures to prevent flow from passing the closed gates.

- **Install grade control structures –** Local backwater effects caused by the Chowchilla Bypass Bifurcation Structure may be contributing to the accumulation of sand in Reach 2A (McBain and Trush 2002), which could mobilize under Interim or Restoration flows, thereby compromising the ability to convey Interim or Restoration flows through downstream reaches. The Settlement does not stipulate any actions to modify the Chowchilla Bypass Bifurcation Structure to address flow loss or sediment deposition due to backwater effects; therefore, a subsequent decision would be required before any such actions could be implemented. Potential actions to address sediment deposition upstream from the Chowchilla Bypass Bifurcation Structure range from no implementation to installing grade control structures to prevent sediment mobilization.

3.2.3 Physical Monitoring and Management Plan

The Physical Monitoring and Management Plan is included in the Draft PEIS/R (Reclamation and DWR 2011), and is summarized here. The Physical Monitoring and Management Plan provides guidelines for observing and adjusting to changes in physical conditions within the Restoration Area. The Physical Monitoring and Management Plan consists of five component plans, addressing interrelated physical conditions including flow, groundwater seepage, channel capacity, propagation of native vegetation, and suitability of spawning gravel. Each component plan identifies objectives for the physical conditions within the Restoration Area, and provides guidelines for the monitoring and management of those conditions. The plans identify potential actions that could be taken to further enhance the achievement of the objectives. The component plans include immediate actions that could be taken, which are analyzed at a project level in this BA. The component plans also include long-term actions that are analyzed at a program level of detail in this BA. Finally, this Plan includes a description of monitoring activities which apply to one or more of the component plans. The five component plans include the following:

- **Flow –** To ensure compliance with the hydrograph releases in Exhibit B of the Settlement and any other applicable flow releases (e.g., Buffer Flows)
- **Seepage –** Reduce or avoid adverse or undesirable seepage impacts
- **Channel capacity** – Maintain flood conveyance capacity
- **Native vegetation** – Establish and maintain native riparian habitat
- **Spawning gravel** – Maintain gravels for spawning

The Physical Monitoring and Management Plan includes monitoring activities and a set of immediate (project level) responses that would be implemented, as needed, to attain the management objectives. The plan also identifies potential long-term (program level) responses that could be implemented to attain the management objectives, if necessary. Monitoring activities and responses are described below. Monitoring and management guidelines related to biological conditions for fish are separately described in Appendix E, “Fisheries Management Plan,” of the Draft PEIS/R (Reclamation and DWR 2011).

Monitoring Activities

Monitoring activities include past, present, and future physical and nonphysical activities within the Restoration Area. Site-specific documentation has been completed for those actions completed or currently underway, and would be completed as necessary for those actions described at a program level of detail in this BA. Monitoring activities, as described in the Physical Monitoring and Management Plan, are guidelines for monitoring and could change as part of implementation of the Settlement. These activities include the following:

- **Flow monitoring –** Flow, cross sections, and surface water stage at six gaging stations, and at additional locations during high-flow events
- **Groundwater level monitoring –** Groundwater elevation in monitoring wells
- **Aerial and topographic surveys –** True color aerial photographs and topographic surveys to assess river stage, hydraulic roughness, river width, bed elevation, and vegetation conditions
- **Vegetation surveys –** Surveys of seed dispersal start and peak times, and native riparian vegetation establishment
- **Sediment mobilization monitoring –** Sediment mobilization, bar formation, and bank erosion through aerial and topographic surveys of areas with elevated erosion potential
- **Spawning gravel monitoring –** Pebble count or photographic surveys of riffles following Normal-Wet or Wet years

Immediate Management Actions – Project Level

Potential immediate responses have been identified to contribute to attaining the seepage, channel capacity, and spawning gravel management objectives. No immediate responses have been identified to contribute to attaining the flow or vegetation management objectives. Potential immediate responses to attain the groundwater seepage, channel capacity, and spawning gravel management objectives include the following:

- **Seepage –** Reduce, redirect, or redivert Interim or Restoration flows to reduce flow in downstream reaches. This could include the following:
  - **Reductions of Interim or Restoration Flow Releases at Friant Dam –** Reductions in the release rate from Friant Dam to limit the potential for seepage impacts to occur downstream. Planned thresholds for reductions at Friant would need to consider travel time and associated response delays.
  - **Redirection of Interim or Restoration Flows at Chowchilla Bypass Bifurcation Structure –** Directing flow into the bypass system at the Chowchilla Bypass Bifurcation Structure would reduce flow in Reach 2B and downstream reaches.

- **Delivery of Interim or Restoration Flows at Mendota Pool –** Delivery of water to Mendota Pool would reduce flows in Reach 3 and downstream reaches.

- **Delivery of Interim or Restoration Flows at Arroyo Canal –** When San Luis Canal Company is not diverting at the full capacity of Arroyo Canal, additional water diversions to the canal would reduce flows in Reach 4A and downstream reaches.

- **Redirection of Interim or Restoration Flows at Sand Slough Control Structure –** During the first year of Interim Flows, water would not be directed into Reach 4B. In subsequent years, diverting flows into the bypass system at Sand Slough Control Structure would reduce flows in Reach 4B.

- **Channel capacity –** Removal of vegetation and debris that would cause Interim or Restoration flows to exceed channel capacity. Vegetation would be removed by mechanical or chemical means. Nonnative plant removal would receive priority over removal of native species.

- **Spawning gravel –** Modify releases from Friant Dam to adjust flows to flush or mobilize based on monitoring reports and recommendations of spawning gravel conditions (including potential modifications to Restoration Flow Guidelines to improve the success of Flushing Flows).

Long-Term Management Actions – Program Level

Potential long-term responses have been identified to contribute to attaining the flow, groundwater seepage, channel capacity, native vegetation, and spawning gravel management objectives. Potential long-term responses to attain the management objectives may require additional environmental documentation, and include the following:

- **Flow –** Paragraph 13(c) of the Settlement provides for adjusting releases due to unexpected seepage losses. These actions could include but would not be limited to acquisition and release of purchased water from willing sellers. The procedures for purchasing and releasing additional water are under development and would be detailed in the Restoration Flow Guidelines, a document that would be attached to the Friant Operation Guidelines.

- **Seepage –** Long-term management actions for seepage may include, but would not be limited to, purchasing easements and/or compensation for seepage effects, construction of slurry walls to reduce seepage flows, construction of seepage berms to protect against levee failure, construction of drainage interceptor ditches to protect affected lands, or installation of tile drains on affected lands.

- **Channel capacity –** Long-term management actions for channel capacity may include, but would not be limited to, providing a larger floodplain between levees through the acquisition of land and construction of setback levees, regrading of land between levees, construction of sediment traps, construction of grade control structures, or channel grading.

- **Native vegetation –** Long-term management actions for native vegetation may include, but would not be limited to, active plantings and irrigation of desired native plants.

- **Spawning gravel –** Long-term management actions for spawning gravel may include, but would not be limited to, gravel augmentation and/or conditioning at existing riffles, establishment of new riffles, engineered channel modifications, construction of sediment traps on the San Joaquin River or tributaries with high sediment loads, or construction of grade control structures.

3.2.4 Conservation Strategy

As part of Settlement implementation, a comprehensive strategy for the conservation of listed and sensitive species and habitats has been prepared, and would be implemented in coordination with USFWS, NMFS, and DFG. The strategy’s purpose is to serve as a tool built into the project description to minimize and avoid potential impacts to sensitive species and habitats. This Conservation Strategy guides development and implementation of specific conservation measures for project- and program-level actions. The Conservation Strategy includes conservation goals and measures for species and communities (such as avoidance, minimization, monitoring, and management measures) consistent with adopted recovery plans, as described below. If avoidance and minimization measures are impractical or infeasible, then further consultation actions and mitigation measures will be pursued and developed in coordination with the appropriate regulatory agency.

To achieve the Restoration Goal, a number of actions that are proposed to be implemented may substantially alter not only the aquatic ecosystem of the San Joaquin River, but also the river's riparian and wetland ecosystems, and some adjacent upland ecosystems. Riparian, wetland, and upland ecosystems of the Central Valley, such as those along the San Joaquin River, provide habitat for a large number of species, including several Federally listed and State-listed species. Therefore, the Proposed Action includes this Conservation Strategy, which would be implemented in a manner that is consistent with adopted conservation plans for sensitive species, and for wetland and riparian ecosystems of the Restoration Area.

The Conservation Strategy consists of management actions that would result in a net benefit for riparian and wetland habitats in the Restoration Area, to avoid reducing the long-term viability of sensitive species, and to be consistent with adopted conservation plans. The goals of the strategy are described below:

- **Conserve riparian vegetation and waters of the United States, including wetlands –** It is anticipated that implementing the Settlement would result in a net increase in the acreage of riparian and wetland vegetation in the Restoration Area. However, several program actions may disturb or eliminate riparian vegetation or waters of the United States (including wetlands). If impacts to waters of the

United States (including wetlands), navigable waters, or the Federal levee system cannot be avoided, a USACE Section 404, Section 408, and/or Section 10 permit and Central Valley Regional Water Quality Control Board (RWQCB) Section 401 water quality certification would be obtained. Increased acreage of wetlands resulting from Interim and Restoration flows may be considered a means of replacing, restoring, or enhancing wetlands. However, the acreage, location, and methods of replacing, restoring, or enhancing wetlands would be determined during these permitting processes.

- **Control and manage invasive species –** Because of their adverse effects on aquatic and riparian ecosystems, the spread of invasive plant species as a result of release of Interim and Restoration flows would be controlled and managed. For each invasive plant species with known infestations, thresholds for management responses and specific management responses would be established and implemented (including species-specific control methods).

- **Conserve special-status species –** Populations of special-status species would benefit from restoring and sustaining riparian and wetland habitat, and controlling invasive species, as described previously. However, during the initiation of Interim and Restoration flows, and the construction of related actions, a variety of special-status species of upland, wetland, and riparian habitats could experience adverse effects. Therefore, this strategy includes measures to prevent or reduce impacts that could result from loss of habitat within project footprints or from impacts on adjacent habitat or species. In addition, this strategy includes coordination with appropriate regulatory agencies to provide mitigation or compensation, consistent with applicable conservation plans, to avoid or minimize effects when actions would result in a net loss of habitat or other substantial adverse effects, if the implementation of avoidance and minimization measures is infeasible or impractical.

These measures address all potentially affected Federally listed and/or State-listed species, and all other species identified by USFWS, NMFS, or DFG as candidates, sensitive, or special-status in local or regional plans, policies, or regulations. For individual project- and program-level actions under the Proposed Action, the applicable, feasible measures would guide development of action-specific conservation strategies. Table 3-4 presents the Conservation Strategy.

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
VP	**Vernal pool habitats, fleshy (succulent) owl's clover, Hoover's spurge, Bogg's Lake hedge-hyssop, Colusa grass, San Joaquin Valley Orcutt grass, hairy Orcutt grass, Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, vernal pool tadpole shrimp, and western spadefoot toad**		
VP-1. Avoid effects to species	a) If vernal pools or vernal pool species are anticipated within a project area, a qualified biologist will identify and map vernal pool and seasonal wetland habitat potentially suitable for listed vernal pool plants, invertebrates, and western spadefoot toad within the project footprint. b) Facility construction and other ground-disturbing activities will be sited to avoid core areas identified in the *Vernal Pool Recovery Plan* (USFWS 2005) because conservation of these areas is a high priority for recovering listed vernal pool species.	Project and Program	USFWS DFG
VP-2. Minimize effects to species	a) If vernal pools are present, a buffer around the microwatershed or a 250-foot-wide buffer, whichever is greater, will be established before ground-disturbing activities around the perimeter of vernal pools and seasonal wetlands that provide suitable habitat for vernal pool crustaceans or vernal pool plants. This buffer will remain until ground-disturbing activities in that area are completed. Suitable habitat and buffer areas will be clearly identified in the field by staking, flagging, or fencing. b) Appropriate fencing will be placed and maintained around all preserved vernal pool habitat buffers during ground-disturbing activities to prevent impacts from vehicles and other construction equipment. c) Worker awareness training and on-site biological monitoring will occur during ground-disturbing activities to ensure buffer areas are being maintained.	Program	Lead Agency
VP-3. Compensate for temporary or permanent loss of habitat	a) If activities occur within the microwatershed or 250-foot-wide buffer for vernal pool habitat will be affected by the SJRRP, the project proponent will develop and implement a compensatory mitigation plan, consistent with the USACE and EPA April 10, 2008, Final Rule for Compensatory Mitigation for Losses of Aquatic Resources (33 CFR Parts 325 and 332 and 40 CFR Part 230) and other applicable regulations and rules at the time of implementation, that will result in no net loss of acreage, function, and value of affected vernal pool habitat. Unavoidable effects will be compensated through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. b) Project effects and compensation will be determined in consideration of the *Vernal Pool Recovery Plan* goals for core areas, which call for 95 percent preservation for habitat in the Grasslands Ecological Area and Madera core areas, and 85 percent habitat preservation in the Fresno core area (USFWS 2005). c) Appropriate compensatory ratios for loss of habitat both in and out of core areas will be determined during coordination and consultation with USFWS and/or DFG, as appropriate.	Project and Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	d) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be and developed as part of the USFWS and/or DFG coordination and consultation process. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase will require an endowment for land management in perpetuity before any project groundbreaking activities.		
CH	**Critical habitat**		
CH-1. Avoid and minimize effects to critical habitat	a) Designated critical habitats shall be identified and mapped. b) All SJRRP actions will be designed to avoid direct and indirect adverse modifications to these areas. c) Minimization measures, such as establishing and maintaining buffers around areas of designated critical habitat, shall be implemented if avoidance is not feasible.	Project and Program	USFWS
CH-2. Compensate for unavoidable adverse effects on Federally designated critical habitat	a) If critical habitat may be adversely modified by the implementation of SJRRP actions, the area to be modified will be evaluated by a qualified biologist to determine the potential magnitude of the project effects (i.e., description of primary constituent elements present and quantification of those affected) at a level of detail necessary to satisfy applicable environmental compliance and permitting requirements. b) Compensatory conservation measures developed through Section 7 consultation with USFWS will be implemented. If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in and developed as part of the USFWS consultation process. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase require an endowment for land management in perpetuity before any project groundbreaking activities.	Project and Program	USFWS
CTS	**California tiger salamander**		
CTS-1. Avoid and minimize effects to species	a) If potential California tiger salamander habitat or species are anticipated within the project area, within 1 year before project construction activities, a qualified biologist shall identify and map potential California tiger salamander habitat (areas within 1.3 miles of known or potential California tiger salamander breeding habitat) within the project footprint. One week before ground-disturbing activities, a qualified biologist will survey for and flag the presence of ground squirrel and gopher burrow complexes. Where burrow complexes are present, a 250-foot-wide buffer shall be placed to avoid and minimize disturbance to the species.	Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	b) Facility construction and other ground-disturbing activities shall be sited to avoid areas of known California tiger salamander habitat and avoidance buffers. c) To eliminate an attraction to predators of the California tiger salamander, all food-related trash items such as wrappers, cans, bottles, and food scraps, must be disposed of in closed containers and removed at least once every day from the entire project site.		
CTS-2. Minimize effects to species	a) Before and during construction activities, construction exclusion fencing will be installed just outside the work limit or around vernal pools where California tiger salamander may occur. This fencing shall be maintained throughout construction and will be removed at the conclusion of ground-disturbing activities. No vehicles will be allowed beyond the exclusion fencing. A USFWS- and DFG-approved biological monitor shall be present on site, during intervals recommended by USFWS and DFG, to inspect the fencing. b) The biological monitor will be on site each day during any wetland restoration or construction, and during initial site grading or development of sites where California tiger salamanders have been found. c) Before the start of work each day, the biological monitor will check for animals under any equipment to be used that day, such as vehicles or stockpiles of items such as pipes. If California tiger salamanders are present, they will be allowed to leave on their own, before the initiation of construction activities for the day. To prevent inadvertent entrapment of California tiger salamanders during construction, all excavated, steep-walled holes or trenches more than 1 foot deep shall be covered, by plywood or similar materials, at the close of each working day or provided with one or more escape ramps constructed of earth fill or wooden planks. Before such holes or trenches are filled, they must be thoroughly inspected for trapped animals. d) Plastic monofilament netting (erosion control matting) or similar material shall not be used at the project site because California tiger salamanders may become entangled or trapped. Acceptable substitutes include coconut coir matting or tackified hydroseeding compounds. e) All ground-disturbing work shall occur during daylight hours. Clearing and grading will be conducted between April 15 and October 15, in coordination with USFWS and DFG, and depending on the level of rainfall and site conditions. f) Revegetation of project areas temporarily disturbed by construction activities will be conducted with locally occurring native plants.	Program	USFWS
CTS-3. Compensate for temporary or permanent loss of habitat	a) If California tiger salamander, or areas within 1.3 miles of known or potential California tiger salamander breeding habitat, would be affected by the SJRRP, the project proponent will develop and implement a compensatory mitigation plan in coordination with USFWS and DFG, as appropriate. Unavoidable effects will be compensated through a combination of creation, preservation, and restoration of habitat or purchase of credits at a mitigation bank approved by the regulatory agencies. b) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in and developed as part of the USFWS and/or DFG coordination and consultation process. The plan will include information on	Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. Any impacts that result in a compensation purchase will require an endowment for land management in perpetuity before any project groundbreaking activities.		
DBC	**Delta button-celery**		
DBC-1. Avoid and minimize loss of habitat and individuals	a) Historically, Delta button celery was known to exist in the Eastside and Mariposa bypasses (CNDDB). In most areas of the bypasses, local flows up to 1,500 cfs remain in the main channel, and do not inundate the floodplain. Maintaining flows at or below 1,500 will not impact Delta button celery populations. In general, historical Delta button celery populations have been located below the 2,500 cfs inundation area (CNDDB). If these historical populations are still thriving in these areas, flows between 1,500 cfs and 2,500 cfs will most likely impact these populations. Potential areas of impact within the Eastside Bypass from the Sand Slough Bypass to the Mariposa Bypass are approximately 400 acres, and for the Mariposa Bypass, approximately 100 acres. Before increasing flows above 1,500 cfs in these specific areas, comprehensive surveys will be conducted. Surveys will include remapping and recensus of the documented occurrences during at least 2 consecutive or nonconsecutive years when habitat conditions are favorable to detect the species to determine the population trend. Status updates for these occurrences will be provided to DFG. b) A Delta button-celery conservation plan will be developed and implemented that includes a preservation and adaptive management strategy for existing occurrences within the Restoration Area. The conservation plan will be developed in collaboration with DFG and other species experts, and be supported by review of the existing literature, including information on species' life history characteristics, historic and current distribution, and microhabitat requirements.	Project and Program	DFG
DBC-2. Avoid and minimize loss of habitat and risk of take for implementation of construction activities	a) If direct impacts to Delta button celery could occur, DFG and the appropriate State lead agency will coordinate to determine specific minimization and mitigation measures	Program	Lead Agency

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
DBC-3. Compensate for temporary or permanent loss of habitat	a) Compensatory mitigation for Delta button-celery will be developed in consultation with DFG. Mitigation may include the development and implementation of habitat creation and enhancement designs to incorporate habitat features for Delta button-celery (e.g., depressions within seasonally inundated areas) into floodplains with potentially suitable habitat conditions. Compensatory mitigation may also include efforts to establish additional populations in the Restoration Area or to enhance existing populations on or off site. Mitigation sites will avoid areas where future SJRRP activities are likely. The project proponent will obtain site access through a conservation easement or in-lieu fee title and will provide adequate funding to implement the required compensation measures, and to monitor compliance with and success of the conservation measures. b) Establishment of new occurrences will be attempted by transplanting seed and plants from affected locations to created habitat or suitable, but unoccupied, existing habitat. c) Monitoring, performance criteria, and protective measures will be applied to compensatory mitigation sites. The replacement requirements and any additional conservation and mitigation measures will be determined in coordination with DFG.	Project and Program	DFG
PALM	**Palmate-bracted bird's beak**		
PALM-1. Avoid and minimize effects to species	a) If palmate-bracted bird's beak is anticipated within the project area, a qualified botanist will identify and map the location of palmate-bracted bird's beak plants within the project footprint, within 1 year before the start of activities that may cause disturbance from either release of flows over 1,660 cfs or from ground-disturbing actions. b) A minimum 500-foot-wide buffer shall be placed around occurrences of palmate-bracted bird's beak during construction activities, consistent with recommendations in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). The 500-foot-wide buffer will be clearly identified in the field by staking, flagging, or fencing. Project activity will avoid buffer areas, and work awareness training and biological monitoring will be conducted to ensure that the buffer area is not encroached on and that effects are being avoided.	Project and Program	USFWS DFG
PALM-2. Compensate for temporary or permanent loss of occupied habitat	a) A compensatory conservation plan shall be developed in coordination with USFWS and DFG, as appropriate. The conservation plan will require the project proponent to maintain viable plant populations in the Restoration Area and will identify compensatory measures for any populations affected. The conservation plan shall include monitoring and reporting requirements for populations to be preserved in or adjacent to construction areas, or populations to be protected or enhanced off site. b) If relocation efforts are part of the conservation plan, the plan will include details on the methods to be used: collection, relocation/transplant potential, storage, propagation, preparation of receptor site, installation, long-term protection and management, monitoring and reporting requirements, and remedial action responsibilities	Project and Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	should the initial effort fail to meet compensation requirements. c) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the conservation plan and must occur with full endowment for management in perpetuity before groundbreaking. The plan will include information on responsible parties for long-term management, holders of conservation easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.		
VELB			
VELB-1. Avoid and minimize effects to species	a) If elderberry shrubs and valley elderberry longhorn beetle are anticipated within the project area, within 1 year before the commencement of ground-disturbing activities, a qualified biologist shall identify any elderberry shrubs in the project footprint. Qualified biologist(s) will survey potentially affected shrubs for valley elderberry longhorn beetle exit holes in stems greater than 1 inch in diameter. b) If elderberry shrubs are found on or adjacent to the construction project site, a 100-foot-wide avoidance buffer – measured from the dripline of the plant – will be established around all elderberry shrubs with stems greater than 1 inch in diameter at ground level and will be clearly identified in the field by staking, flagging, or fencing. No activities will occur within the buffer areas and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	Project and Program	USFWS
VELB -2. Compensate for temporary or permanent loss of habitat	a) The project proponent will consult with USFWS to determine appropriate compensation ratios. Compensatory mitigation measures will be consistent with the *Conservation Guidelines for Valley Elderberry Longhorn Beetle* (USFWS 1999a), or current guidance. b) Compensatory mitigation for adverse effects may include transplanting elderberry shrubs during the dormant season (November 1 to February 15), if feasible, to an area protected in perpetuity, as well as required additional elderberry and associated native plantings and approved by USFWS. c) If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	Project and Program	USFWS

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
BNLL	**Blunt-nosed leopard lizard**		
BNLL-1. Avoid and minimize effects to species	a) Three areas have been identified as having potential blunt-nosed leopard lizard habitat based on aerial maps. These areas include approximately 2,460 acres along the southwest side of the San Joaquin River in Reach 2, approximately 490 acres in a portion of the Eastside Bypass and adjacent lands near Reach 4A of the San Joaquin River, and approximately 2,938 acres encompassing the northern side of the Mariposa Bypass and parcels north of the Mariposa Bypass and west of the Eastside Bypass. Within 1 year before the commencement of the proposed project, focused site visits and habitat assessment will be conducted on these lands. Based on focused assessment, and discussions with the USFWS and DFG, protocol-level surveys may be conducted. If blunt-nosed leopard lizard are detected within or adjacent to the project site, measures that will avoid direct take of this species will be developed in cooperation with USFWS and DFG and implemented before ground disturbing activities. (DWR 2010).	Project and Program	USFWS DFG
BNLL-2. Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with USFWS and DFG as appropriate.	Program	USFWS DFG
PLANTS	**Other special-status plants**		
PLANTS-1. Avoid and minimize effects to special-status plants	a) Within 1 year before the commencement of ground-disturbing activities, habitat assessment surveys for the special-status plants listed in Appendix L of the Draft PEIS/R (Reclamation and DWR 2011), will be conducted by a qualified botanist, in accordance with the most recent USFWS and DFG guidelines and at the appropriate time of year when the target species would be in flower or otherwise clearly identifiable. b) Locations of special-status plant populations will be clearly identified in the field by staking, flagging, or fencing a minimum 100-foot-wide buffer around them before the commencement of activities that may cause disturbance. No activity shall occur within the buffer area, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented. c) Some special-status plant species are annual plants, meaning that a plant completes its entire life cycle in one growing season. Other special-status plant species are perennial plants that return year after year until they reach full maturity. Because of the differences in plant life histories, all general conservation measures will be developed on a case-by-case basis and will include strategies that are species- and site-specific to avoid impacts to special-status plants.	Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
PLANTS-2. Compensate for temporary or permanent loss of special-status plants	a) USFWS and/or DFG will be consulted to determine appropriate compensation measures for the loss of special-status plants, as appropriate. b) Appropriate mitigation measures may include the creation of off-site populations through seed collection or transplanting, preservation and enhancement of existing populations, restoration or creation of suitable habitat, or the purchase of credits at a regulatory-agency-approved mitigation bank. If off-site compensation includes dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	Program	USFWS DFG
GGS			
GGS-1. Avoid and minimize loss of habitat for giant garter snake	a) If giant garter snake habitat is anticipated to be present within the project area, preconstruction surveys will be completed by a qualified biologist approved by USFWS and DFG within a 24-hour period before any ground disturbance of potential giant garter snake habitat. If construction activities stop on the project site for a period of 2 weeks or more, a new giant garter snake survey will be completed no more than 24 hours before the restart of construction activities. Avoidance of suitable giant garter snake habitat, as defined by USFWS (USFWS 1993) and DFG, will occur by demarcating and maintaining a 300-foot-wide buffer around these areas. b) For projects within potential giant garter snake habitat, all activity involving disturbance of potential giant garter snake habitat will be restricted to the period between May 1 and October 1, the active season for giant garter snakes. The construction site shall be reinspected if a lapse in construction activity of 2 weeks or greater has occurred. c) Clearing will be confined to the minimal area necessary to facilitate construction activities. Giant garter snake habitat within or adjacent to the project will be flagged, staked, or fenced and designated as an Environmentally Sensitive Area. No activity shall occur within this area, and USFWS-approved worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented. Construction activities shall be minimized within 200 feet of the banks of giant garter snake habitat. Movement of heavy equipment will be confined to existing roadways to minimize habitat disturbance. d) Vegetation shall be hand-cleared in areas where giant garter snakes are suspected to occur. Exclusionary fencing with one-way exit funnels shall be installed at least 1 month before activities to allow the species to passively leave the area and to prevent reentry into work zones, per USFWS and/or DFG guidance. e) If a giant garter snake is found during construction activities, USFWS, DFG, and the project's biological monitor will immediately be notified. The biological monitor, or his/her assignee, will stop construction in the vicinity of the find and allow the snake to leave on its own. The monitor will remain in the area for the	Program	Lead Agency USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	remainder of the work day to ensure the snake is not harmed. Escape routes for giant garter snake should be determined in advance of construction and snakes will be allowed to leave on their own. If a giant garter snake does not leave on its own within 1 working day, USFWS and DFG will be consulted. f) All construction-related holes shall be covered to prevent entrapment of individuals. Where applicable, construction areas shall be dewatered 2 weeks before the start of activities to allow giant garter snakes and their prey to move out of the area before any disturbance.		
GGS-2. Compensate for temporary or permanent loss of habitat	a) Temporarily affected giant garter snake aquatic habitat will be restored in accordance with criteria listed in the USFWS *Mitigation Criteria for Restoration and/or Replacement of Giant Garter Snake Habitat* (Appendix A to Programmatic Formal Consultation for USACE 404 Permitted Projects with Relatively Small Effects on the Giant Garter Snake Within Butte, Colusa, Glenn, Fresno, Merced, Sacramento, San Joaquin, Solano, Stanislaus, Sutter, and Yolo Counties, California (USFWS 1997)), or the most current criteria from USFWS or DFG. b) Permanent loss of giant garter snake habitat will be compensated at a ratio and in a manner consulted on with USFWS and DFG. Compensation may include preservation and enhancement of existing populations, restoration or creation of suitable habitat, or purchase of credits at a regulatory-agency-approved mitigation bank in sufficient quantity to compensate for the effect. Credit purchases, land preservation, or land enhancement to minimize effects to giant garter snakes should occur geographically close to the impact area. If off-site compensation is chosen, it shall include dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.	Program	USFWS DFG
WPT			
WPT-1. Avoid and minimize loss of individuals	a) A qualified biologist will conduct surveys in aquatic habitats to be dewatered and/or filled during project construction. Surveys will be conducted immediately after dewatering and before fill of aquatic habitat suitable for western pond turtles. If western pond turtles are found, the biologist will capture them and move them to nearby USFWS- and/or DFG-approved areas of suitable habitat that will not be disturbed by project construction.	Program	DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
EAGLE	**Bald eagle and golden eagle**		
EAGLE-1. Avoid and minimize effects to bald and golden eagles (as defined in the Bald and Golden Eagle Protection Act)	a) Surveys for bald and golden eagle nests will be conducted within 2 miles of any proposed project within areas supporting suitable nesting habitat and important eagle roost sites and foraging areas. These surveys will be conducted in accordance with the USFWS *Protocol for Evaluating Bald Eagle Habitat and Populations in California* and DFG *Bald Eagle Breeding Survey Instructions* or current guidance (*USFWS Draft Project Design Criteria and Guidance for Bald and Golden Eagles)*. b) If an active eagle's nest is found, project disturbance will not occur within ½ mile of the active nest site during the breeding season (typically December 30 to July 1) or any project disturbance if it is shown to disturb the nesting birds. A no-disturbance buffer will be established around the nest site for construction activities in consultation with USFWS and DFG, and will depend on ecological factors, including topography, surrounding vegetation, nest height, and distance to foraging habitat, as well as the type and magnitude of disturbance. c) Project activity will not occur within the ½-mile-buffer areas, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	Program	USFWS DFG
SWH			
SWH-1. Avoid and minimize impacts to Swainson's Hawk	a) Preconstruction surveys for active Swainson's hawk nests will be conducted in and around all potential nest trees within 0.5 miles of project-related disturbance (including construction-related traffic). These surveys will be conducted in accordance with the *Recommended Timing and Methodology for Swainson's Hawk Nesting Surveys in California's Central Valley* (Swainson's Hawk Technical Advisory Committee, 2000) or current guidance. b) If known or active nests are identified through preconstruction surveys or other means, a ½ mile no-disturbance buffer shall be established around all active nest sites if construction cannot be limited to occur outside the nesting season (February 15 through September 15). c) Worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	Program	DFG
SWH-2. Compensate for loss of nest trees and foraging habitat	a) If foraging habitat for Swainson's hawk is removed in association with project implementation, foraging habitat compensation will occur in coordination with DFG. Foraging habitat mitigation may consist of planting and establishing alfalfa, row crops, pasture, or fallow fields. b) If potential nesting trees are to be removed during construction activities, removal will take place outside of Swainson's hawk nesting season, and the project proponent will develop a plan to replace known Swainson's hawk nest trees with a number of equivalent native trees that were previously determined to be impacts through consultation with DFG. Compensation shall include dedication of conservation easements, purchase of mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan	Program	DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations.		
RAPTOR			
RAPTOR-1. Avoid and minimize loss of individual raptors	a) Construction activity, including vegetation removal, will only occur outside the typical breeding season for raptors (September 16 to December 13), if raptors are determined to be present. b) Preconstruction surveys will be conducted by a qualified biologist in areas of suitable habitat to identify active nests in the project footprint. c) If active nests are located in the project footprint, a no-disturbance buffer will be established until a qualified biologist determines that the nest is no longer active. The size of the buffer shall be established by a qualified biologist in coordination with DFG based on the sensitivity of the resource, the type of disturbance activity, and nesting stage. No activity shall occur within the buffer area, and worker awareness training and biological monitoring will be conducted to ensure that avoidance measures are being implemented.	Program	DFG
RAPTOR-2. Compensate for loss of nest trees	a) Native trees removed during project activities will be replaced with an appropriate number of native trees, in coordination with DFG.	Program	DFG
MBTA			
MBTA-1. Avoid and minimize effects to species	a) Native nesting birds will be avoided by not conducting project activity, including vegetation removal, during the typical breeding season (February 1 to September 1), if species covered under the Migratory Bird Treaty Act and Fish and Game Code Sections 3503, 3503.5, and 3513 are determined to be present. b) An Avian Protection Plan shall be established in coordination with USFWS and DFG. Any overhead utility companies within the project area, whose lines, poles, or towers may be moved in association with the project, will also be consulted as part of the Avian Protection Plan.	Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
BRO	Burrowing owl		
BRO-1. Avoid loss of species	a) Preconstruction surveys for burrowing owls will be conducted in areas supporting potentially suitable habitat and within 30 days before the start of construction activities. If ground-disturbing activities are delayed or suspended for more than 30 days after the preconstruction survey, the site should be resurveyed. These surveys and mitigation will be conducted in accordance with the *Burrowing Owl Survey Protocol and Mitigation Guidelines*, (The California Burrowing Owl Consortium, 1993) or current guidance. b) Occupied burrows shall not be disturbed during the breeding season (February 1 through August 31). A minimum 160-foot-wide buffer shall be placed around occupied burrows during the nonbreeding season (September 1 through January 31), and a 250-foot-wide buffer shall be placed around occupied burrows during the breeding season. Ground-disturbing activities shall not occur within the designated buffers.	Program	DFG
BRO-2. Minimize impacts to species	a) If a DFG-approved biologist can verify through noninvasive methods that owls have not begun egg-laying and incubation, or that juveniles from occupied burrows are foraging independently and are capable of independent survival, a plan shall be coordinated with DFG to offset burrow habitat and foraging areas on the project site if burrows and foraging areas are taken by SJRRP actions. Mitigation measures will be consistent with the *Draft Staff Report on Burrowing owl Mitigation* (DFG 1994), or current guidance. b) If destruction of occupied burrows occurs, existing unsuitable burrows should be enhanced (enlarged or cleared of debris) or new burrows created. This should be done in consultation with DFG. c) Passive owl relocation techniques must be implemented. Owls should be excluded from burrows in the immediate impact zone within a 160-foot-wide buffer zone by installing one-way doors in burrow entrances. These doors shall be in place at least 48 hours before excavation to insure the owls have departed. d) The project area shall be monitored daily for 1 week to confirm owl departure from burrows before any ground-disturbing activities. e) Where possible, burrows should be excavated using hand tools and refilled to prevent reoccupation. Sections of flexible plastic pipe should be inserted into the tunnels during excavation to maintain an escape route for any animals inside the burrow.	Program	DFG
BAT			
BAT-1. Avoid and minimize loss of species	a) If suitable roosting habitat for special-status bats will be affected by project construction (e.g., removal of buildings, modification of bridges), surveys for roosting bats on the project site will be conducted by a qualified biologist. The type of survey will depend on the condition of the potential roosting habitat and may include visual surveys or use of acoustic detectors. Visual surveys may consist of a daytime pedestrian survey for evidence of bat use (e.g., guano) and/or an evening emergence survey for the presence or absence of bats and will include trees within ¼ mile of project construction activities. The type of survey will	Program	DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	depend on the condition of the potential roosting habitat. If no bat roosts are found, then no further study is required. b) If evidence of bat use is observed, the number and species of bats using the roost will be determined. Bat detectors may be used to supplement survey efforts. c) If roosts are determined to be present and must be removed, the bats will be excluded from the roosting site before the facility is removed. A mitigation program addressing compensation, exclusion methods, and roost removal procedures will be developed in consultation with DFG before implementation. Exclusion methods may include use of one-way doors at roost entrances (bats may leave, but not reenter), or sealing roost entrances when a site can be confirmed to contain no bats. Exclusion efforts may be restricted during periods of sensitive activity (e.g., during hibernation or while females in maternity colonies are nursing young).		
BAT-2. Compensate for loss of habitat	a) The loss of each roost will be replaced, in consultation with DFG, and may include construction and installation of bat boxes suitable to the bat species and colony size excluded from the original roosting site. Roost replacement will be implemented before bats are excluded from the original roost sites. Once the replacement roosts are constructed and it is confirmed that bats are not present in the original roost sites, the structure may be removed.	Program	DFG
SJAS			
SJAS-1. Avoid and minimize loss of individuals	a) A 50-foot-wide minimum buffer shall be maintained from all small mammal burrows of suitable size for San Joaquin antelope squirrel. b) If work is to occur within the 50-foot-wide buffer, a qualified, permitted biologist shall conduct focused visual surveys for San Joaquin antelope squirrel within a 500-foot-wide buffer of the work area. These surveys shall coincide with the squirrels' most active season, April 1 to September 30, and shall be conducted only when air temperatures are between 20° to 30° C (68° to 86° F). Surveys should be conducted using daytime line transects with 10- to 30-meter spacing. Focused live trapping may also be required, in coordination with DFG. If San Joaquin antelope squirrels are observed during surveys, no vegetation or soil disturbance will be allowed within 50 feet of occupied burrows or burrow systems until the individuals are determined to no longer be occupying the area, as determined by a qualified biologist. c) Focused surveys, which may involve live trapping, may be required, in coordination with DFG, as appropriate. Additional conservation measures may developed pending the results of surveys, and in consultation with DFG. d) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.	Program	DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
SJAS-2: Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with DFG, as appropriate.	Program	DFG
FKR	**Fresno kangaroo rat**		
FKR-1. Avoid and minimize effects to species	a) Preconstruction surveys will be conducted by a qualified biologist per USFWS and DFG survey methodology to determine if potential burrows for Fresno kangaroo rat are present in the project footprint. Surveys will be conducted within 30 days before ground-disturbing activities. The biologist will conduct burrow searches by systematically walking transects, which shall be adjusted based on vegetation height and topography, and in coordination with USFWS and DFG. Transects shall be used to identify the presence of kangaroo rat burrows. When burrows are found within 100 feet of the proposed project footprint, focused live trapping surveys shall be conducted by a qualified and permitted biologist, following a methodology approved in advance by USFWS and DFG. Additional conservation measures may be developed pending the results of surveys, and in consultation with USFWS and DFG. b) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.	Program	USFWS DFG
FKR-2. Avoid disturbance of designated critical habitat	a) Facility construction and modification and other restoration projects shall be sited to avoid primary constituent elements of designated critical habitat for Fresno kangaroo rat.	Program	USFWS DFG
FKR-3: Compensate for temporary or permanent loss of habitat or species	a) Compensation for impacts to the species, if needed, will be determined in coordination with DFG and USFWS, as appropriate.	Program	USFWS DFG
SJKF	**San Joaquin kit fox**		
SJKF-1. Avoid and minimize effects to	a) A qualified biologist will conduct preconstruction surveys no less than 14 days and no more than 30 days before the commencement of activities to identify potential dens more than 5 inches in diameter. The project proponent shall implement USFWS' (1999b) *Standardized Recommendations for Protection of San Joaquin*	Program	USFWS DFG

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
species	*Kit Fox Prior to or During Ground Disturbance.* The project proponent will notify USFWS and DFG in writing of the results of the preconstruction survey within 30 days after these activities are completed. b) If dens are located within the proposed work area, and cannot be avoided during construction activities, a USFWS-approved biologist will determine if the dens are occupied. c) If occupied dens are present within the proposed work, their disturbance and destruction shall be avoided. Exclusion zones will be implemented following the latest USFWS procedures (currently USFWS 1999b). d) The project proponent will notify USFWS and DFG immediately if a natal or pupping den is found in the survey area. The project proponent will present the results of preactivity den searches within 5 days after these activities are completed and before the start of construction activities in the area. e) Construction activities shall be conducted when they are least likely to affect the species (i.e., after the normal breeding season). This timing shall be coordinated with USFWS and DFG.		
SJKF-2. Compensate for loss of habitat	a) The project proponent, in coordination with USFWS and DFG, will determine if kit fox den removal is appropriate. If unoccupied dens need to be removed, the USFWS-approved biologist shall remove these dens by hand-excavating them in accordance with USFWS procedures (USFWS 1999b). b) Additional conservation measures will be coordinated with USFWS and DFG, and may include replacing dens, installing off-site artificial dens, acquiring compensation habitat, or other options to be determined. Compensation may include dedicating conservation easements, purchasing mitigation credits, or other off-site conservation measures, and the details of these measures will be included in the mitigation plan and must occur with full endowments for management in perpetuity. The plan will include information on responsible parties for long-term management, holders of conservations easements, long-term management requirements, and other details, as appropriate, for the preservation of long-term viable populations. c) The project proponent will present the results of den excavations to USFWS and DFG within 5 days after these activities are completed.	Program	USFWS DFG
PL	**Pacific lamprey**		
PL-1. Avoid and minimize effects to species	a) A qualified biologist will conduct preconstruction surveys as outlined in Attachment A of USFWS' *Best Management Practices to Minimize Adverse Effects to Pacific Lamprey (Entosphenus tridentatus)* (2010). b) Work in documented areas of Pacific lamprey presence will be timed to avoid in-channel work during typical lamprey spawning (March 1 to July 1). c) If temporary dewatering in documented areas of lamprey presence is required for instream channel work, salvage methods shall be implemented to capture and move ammocoetes to a safe area, in consultation with USFWS.	Program	USFWS

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
DS	**Delta smelt**		
DS-1. Avoid and minimize effects to species	a) All in-water work within delta smelt habitat, as defined by most recent USFWS guidance, shall be confined to a seasonal work window of August 1 - November 30, when delta smelt are least likely to be present. Because this species does not regulate its movements strictly within this time frame, modifications to the work windows may be approved by USFWS before project implementation, based on information from the various in-Delta monitoring programs. b) If activities occur within Delta smelt habitat, measure will be taken to maintain or increase shading of suitable shallow water habitat. The project will also avoid areas deemed suitable for delta smelt habitat that have established aquatic vegetation or have not been previously disturbed.	Program	USFWS DFG
RHSNC	**Riparian habitat and other sensitive natural communities**		
RHSNC-1. Avoid and minimize loss of riparian habitat and other sensitive natural communities	a) Biological surveys will be conducted to identify, map, and quantify riparian and other sensitive habitats in potential construction areas. b) Construction activities will be avoided in areas containing sensitive natural communities, as appropriate. c) If effects occur to riparian habitat, emergent wetland, or other sensitive natural communities associated with streams, the State lead agency will comply with Section 1602 of the California Fish and Game Code; compliance may include measures to protect fish and wildlife resources during the project.	Project and Program	DFG
RHSNC-2. Compensate for loss of riparian habitat and other sensitive natural communities	a) The Riparian Habitat Mitigation and Monitoring Plan for the SJRRP will be developed and implemented in coordination with DFG. Credits for increased acreage or improved ecological function or riparian and wetland habitats resulting from the implementation of SJRRP actions will be applied as compensatory mitigation before additional compensatory measures are required. b) If losses of other sensitive natural communities (e.g., recognized as sensitive by CNDDB, but not protected under other regulations or policies) would not be offset by the benefits of the SJRRP, then additional compensation will be provided through creating, restoring, or preserving in perpetuity in-kind communities at a sufficient ratio for no net loss of habitat function or acreage. The appropriate ratio will be determined in consultation with USFWS, NMFS, and/or DFG, depending on agency jurisdiction.	Project and Program	DFG
WUS	**Waters of the United States/waters of the State**		
WUS-1. Identify and quantify wetlands and other waters of	a) Before SJRRP actions that may affect waters of the United States or waters of the State, Reclamation will map the distribution of wetlands (including vernal pools and other seasonal wetlands) in the Eastside and Mariposa bypasses. b) The project proponent will determine, based on the mapped distribution of these wetlands and hydraulic	Project and Program	USACE

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
the United States	modeling and field observation, the acreage of effects, if any, on waters of the United States. c) If it is determined that vernal pools or other seasonal wetlands will be affected by the SJRRP, the project proponent will conduct a delineation of waters of the United States, and submit the delineation to USACE for verification. The delineation will be conducted according to methods established in the USACE *Wetlands Delineation Manual* (Environmental Laboratory 1987) and *Arid West Supplement* (Environmental Laboratory 2008). d) Construction and modification of road crossings, control structures, fish barriers, fish passages, and other structures will be designed to minimize effects on waters of the United States and waters of the State, and will employ BMPs to avoid indirect effects on water quality.		
WUS-2. Obtain permits and compensate for any loss of wetlands and other waters of the United States/waters of the State	a) The project proponent, in coordination with USACE, will determine the acreage of effects on waters of the United States and waters of the State that will result from implementation of the SJRRP. b) The project proponent will adhere to a "no net loss" basis for the acreage of wetlands and other waters of the United States and waters of the State that will be removed and/or degraded. Wetland habitat will be restored, enhanced, and/or replaced at acreages and locations and by methods agreed on by USACE, the Central Valley RWQCB, and DFG, as appropriate, depending on agency jurisdiction. c) The project proponent will obtain Section 404 and Section 401 permits and comply with all permit terms. The acreage, location, and methods for compensation will be determined during the Section 401 and Section 404 permitting processes. e) The compensation will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of this Draft PEIS/R).	Project and Program	USACE
INV	**Invasive plants**		
INV-1. Implement the Invasive Vegetation Monitoring and Management Plan	a) Reclamation and the project lead agencies will implement the Invasive Vegetation Monitoring and Management Plan for the SJRRP (Appendix L of the Draft PEIS/R (Reclamation and DWR 2011)), which includes measures to monitor, control, and where possible eradicate, invasive plant infestations during flow releases and construction activities. b) The implementation of the Invasive Vegetation Monitoring and Management Plan (Appendix L of the PEIS/R (Reclamation and DWR 2011)) will include monitoring procedures, thresholds for management responses, success criteria, and adaptive management measures for controlling invasive plant species. c) The control of invasive weeds and other recommended actions in the Invasive Vegetation Monitoring and Management Plan (Appendix L of the Draft PEIS/R (Reclamation and DWR 2011)) will be consistent with recommendations in the Fish and Wildlife Coordination Act Report (Appendix F of the Draft PEIS/R (Reclamation and DWR 2011)).	Project and Program	Lead Agency

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
CP	**Conservation plans**		
CP-1. Remain consistent with approved conservation plans	a) Facility siting and construction activities will be conducted in a manner consistent with the goals and strategies of adopted habitat conservation plans, natural community conservation plans, or other approved local, regional, or State habitat conservation plans to the extent feasible. Coordination shall occur with USFWS and/or DFG, as appropriate.	Program	USFWS DFG
CP-2. Compensate effects consistent with approved conservation plans	a) The project proponent shall compensate effects consistent with applicable conservation plans and implement all applicable measures required by the plans.	Program	USFWS DFG
GS	**Southern distinct population segment of North American green sturgeon**		
GS-1. Avoid and minimize loss of habitat and individuals	a) The SJRRP will be operated in such a way that actions within green sturgeon habitat shall be done in accordance with existing operating criteria of the CVP and SWP, and prevailing and relevant laws, regulations, BOs, and court orders in place when the action(s) are performed.	Project and Program	NMFS
CVS	**Central Valley steelhead**		
CVS-1. Avoid loss of habitat and risk of take of species	a) Impacts to habitat conditions (i.e., changes in flows potentially resulting in decreased flows in the tributaries, increases in temperature, increases in pollutant concentration, change in recirculation/recapture rates and methods, decrease in floodplain connectivity, removal of riparian vegetation, decreased in quality rearing habitat, etc.) must be analyzed in consultation with NMFS. b) The Hills Ferry Barrier will be operated and maintained to exclude Central Valley steelhead from the Restoration Area during construction activities and until suitable habitat conditions are restored. c) Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive. d) Before implementation of site-specific actions, the action agency shall conduct an education program for all agency and contracted employees relative to the Federally listed species that may be encountered within the study area of the action, and required practices for their avoidance and protection. A NMFS-appointed representative shall be identified to employees and contractors to ensure that questions regarding avoidance and protection measures are addressed in a timely manner. e) Disturbance of riparian vegetation will be avoided to the greatest extent practicable.	Project and Program	NMFS

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	f) A spill prevention plan will be prepared describing measures to be taken to minimize the risk of fluids or other materials used during construction (e.g., oils, transmission and hydraulic fluids, cement, fuel) from entering the San Joaquin River or contaminating riparian areas adjacent to the river itself. In addition to a spill prevention plan, a cleanup protocol will be developed before construction begins and shall be implemented in case of a spill. g) Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, shall be restricted to the designated construction staging areas, exclusive of any riparian and wetland areas. h) A qualified biological monitor will be present during all construction activities, including clearing, grubbing, pruning, and trimming of vegetation at each job site during construction initiation, midway through construction, and at the close of construction, to monitor implementation of conservation measures and water quality. i) The San Joaquin River channel shall be designed to decrease or eliminate predator holding habitat, in coordination with NMFS.		
CVS-2. Minimize loss of habitat and risk of take of species	a) In-channel construction activities that could affect designated critical habitat for Central Valley steelhead will be limited to the low-flow period between June 1 and October 1 to minimize potential for adversely affecting Federally listed anadromous salmonids during their emigration period. b) In-channel construction activities that could affect designated critical habitat for Central Valley steelhead will be limited to daylight hours during weekdays, leaving a nighttime and weekend period of passage for Federally listed fish species. c) Construction BMPs for off-channel staging, and storage of equipment and vehicles, will be implemented to minimize the risk of contaminating the waters of the San Joaquin River by spilled materials. BMPs will also include minimization of erosion and stormwater runoff, as appropriate. d) Riparian vegetation removed or damaged will be replaced at a ratio, coordinated with NMFS, within the immediate area of the disturbance to maintain habitat quality. e) If individuals of listed species are observed present within a project area, NMFS must be notified. NMFS personnel shall have access to construction sites during construction, and following completion, to evaluate species presence and condition and/or habitat conditions. f) If bank stabilization activities should be necessary, then such stabilization shall be constructed to minimize predator habitat, minimize erosion potential, and contain material suitable for supporting riparian vegetation.	Program	NMFS
WRCS	**Sacramento Valley winter-run Chinook salmon**		
WRCS-1. Avoid and minimize loss of habitat and individuals	a) The SJRRP will be operated in such a way that actions related to the SJRRP in the vicinity of winter-run Chinook salmon habitat shall be performed in accordance with existing operating criteria of the CVP and SWP, and prevailing and relevant laws, regulations, BOs, and court orders in place at the time the actions are performed.		

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
SRCS	**Central Valley spring-run Chinook salmon**		
SRCS-1. Avoid and minimize loss of habitat and individuals	a) The SJRRP will be operated in such a way that actions in the vicinity of spring-run Chinook salmon habitat shall be done in accordance with existing operating criteria of the CVP and SWP, and prevailing and relevant laws, regulations, BOs, and court orders in place at the time the actions are performed. b) SJRRP actions shall be performed in accordance with the Experimental Population 4(d) rule, as it is developed, and where applicable.	Project and Program	NMFS DFG
EFH	**Essential fish habitat (Pacific salmonids and starry flounder)**		
EFH-1. Avoid loss of habitat and risk of take of species	a) Impacts to habitat conditions (e.g., changes in flows potentially resulting in decreased flows in the tributaries, increases in temperature, increases in pollutant concentration, change in recirculation/recapture rates and methods, decrease in floodplain connectivity, removal of riparian vegetation, decreased in quality rearing habitat) must be analyzed in consultation with NMFS. b) The Hills Ferry Barrier will be operated and maintained to exclude Pacific salmonids from the Restoration Area during construction activities, and until suitable habitat conditions are restored. The period of operation under this measure may vary from historical operations. c) Maintenance of conservation measures will be conducted to the extent necessary to ensure that the overall long-term habitat effects of the project are positive. d) Before implementation of site-specific actions, the action agency shall conduct an education program for all agency and contracted employees relative to the Federally listed species that may be encountered within the study area of the action, and required practices for their avoidance and protection. A NMFS-appointed representative shall be identified to employees and contractors to ensure that questions regarding avoidance and protection measures are addressed in a timely manner. e) Disturbance of riparian vegetation will be avoided to the greatest extent practicable. f) A spill prevention plan will be prepared describing measures to be taken to minimize the risk of fluids or other materials used during construction (e.g., oils, transmission and hydraulic fluids, cement, fuel) from entering the San Joaquin River or contaminating riparian areas adjacent to the river itself. In addition to a spill prevention plan, a cleanup protocol will be developed before construction begins and shall be implemented in case of a spill. g) Stockpiling of materials, including portable equipment, vehicles and supplies, such as chemicals, shall be restricted to the designated construction staging areas, exclusive of any riparian and wetland areas.	Project and Program	NMFS

Table 3-4.
Conservation Measures for Biological Resources That May Be Affected by Settlement Actions (contd.)

Conservation Measure and Identifier	Applicable Habitat and/or Species, and Conservation Measure Description	Level of Compliance	Regulatory Agency
	h) A qualified biological monitor will be present during all construction activities, including clearing, grubbing, pruning, and trimming of vegetation at each job site during construction initiation, midway through construction, and at the close of construction to monitor implementation of conservation measures and water quality. i) The bottom topography of the San Joaquin River channel will be designed to decrease or eliminate predator holding habitat.		
EFH-2. Minimize loss of habitat and risk of take from implementation of construction activities	a) In-channel construction activities that could affect habitat for will be limited to the low-flow period between June 1 and October 1 to minimize potential for adversely affecting Federally listed anadromous salmonids during their emigration period. b) In-channel construction activities that could affect habitat for starry flounder and Pacific salmonids will be limited to daylight hours during weekdays, leaving a nighttime and weekend period of passage for Federally listed fish species. c) Construction BMPs for off-channel staging and storage of equipment and vehicles will be implemented to minimize the risk of contaminating the waters of the San Joaquin River by spilled materials. BMPs will also include minimization of erosion and stormwater runoff, as appropriate. d) Riparian vegetation removed or damaged will be replaced at a ratio, coordinated with NMFS, within the immediate area of the disturbance to maintain habitat quality. e) If individuals of listed species are observed present within a project area, NMFS must be notified. NMFS personnel shall have access to construction sites during construction and following completion to evaluate species presence and condition and/or habitat conditions. f) If bank stabilization activities should be necessary, then such stabilization shall be constructed to minimize predator habitat, minimize erosion potential, and contain material suitable for supporting riparian vegetation. Biostabilization techniques shall be used whenever feasible.	Program	NMFS

Key:
°C = degrees Celsius
°F = degrees Fahrenheit
BMP = best management practice
BO = Biological Opinion
CFR = Code of Federal Regulations
cfs = cubic feet per second
CNDDB = California Natural Diversity Database
CVP = Central Valley Project
DFG = California Department of Fish and Game
DWR = California Department of Water Resources
EPA = Federal Environmental Protection Agency
NMFS = National Marine Fisheries Service
PEIS/R = Program Environmental Impacts Statement/Report
Reclamation = U.S. Department of the Interior, Bureau of Reclamation
RWQCB = Regional Water Quality Control Board
Settlement = Stipulation of Settlement in *NRDC, et al,. v. Kirk Rodgers, et al.*
SJRRP = San Joaquin River Restoration Program
State = State of California
SWP = State Water Project
USACE = U.S. Army Corps of Engineers
USFWS = U.S. Fish and Wildlife Services

3.3 Relationship to Related Projects

3.3.1 Federal Energy Regulatory Commission Ruling on Tuolumne River (Project No 2299-065)

The 1995 *New Don Pedro Settlement Agreement* contains instream flow requirements on the Tuolumne River for the anadromous fishery downstream from the project (Federal Energy Regulatory Commission (FERC) 1995). NMFS, USFWS, and DFG, as well as several non-governmental organizations, have sought to modify the requirements to provide flow and related conditions they believe are necessary to protect threatened Central Valley steelhead and their designated critical habitat and EFH for Chinook salmon pursuant to the Magnuson-Stevens Fishery Conservation and Management Act. The recommendations are being considered by FERC and no decision has been made at this time. The FERC ruling could result in increased flow releases from Don Pedro Reservoir that would increase flows in the San Joaquin River downstream from its confluence with Tuolumne River, and thus could affect flow conditions within the San Joaquin River during implementation of the Proposed Action. In such an event, the Reclamation would work with the fish agencies to evaluate resulting changes in flows to ensure that listed species are not adversely affected by the Proposed Action. The most recent flow schedule for 2010-2011 is available at http://tuolumnerivertac.com/FERC%20FLows_2010_2011.pdf.

Specific flow conditions that are being addressed and could change as a result of a FERC decision include:

- Spawning flow – October 1 to March 31
- Attraction pulse flows – Fall
- Outmigration flows – Spring
- Oversummering flow – June 1 through September 30

The November 20, 2009, *Final Report of the Presiding Judge on Interim Measures* recommends additional studies to determine the effects of increased stream flow releases and other modifications of operations on the viability of fall-run Chinook salmon and steelhead populations in the lower Tuolumne River (FERC 2009).

3.3.2 Hills Ferry Barrier

As described in the WY 2010 Final Environmental Assessment (EA)/Initial Study (IS) and the Supplemental WY 2011 Final EA, the Hills Ferry Barrier is a resistance weir consisting of panels aligned perpendicular to the flow of the river with evenly spaced pipes that allow water, small fish, and particles to pass but prevent larger fish such as adult Chinook salmon from passing upstream. The barrier’s main purpose is to redirect upstream-migrating adult fall-run Chinook salmon into suitable spawning habitat in the Merced River and impede migration into the mainstem San Joaquin River upstream, where conditions are currently unsuitable for Chinook salmon. The barrier has been operated by DFG on the San Joaquin River since 1992. The SJRRP is conducting an evaluation of the Hills Ferry Barrier to assess the effectiveness of the barrier in blocking the upstream passage of Chinook salmon and steelhead into the San Joaquin River.

The barrier is usually installed and operated from mid-September through mid-December each year. The barrier is staffed 24 hours a day to visually monitor its success, remove accumulated debris and assist boaters in passing the structure. The barrier has been highly effective at redirecting salmon, but is not without limitations. The barrier's effective sustained flow capacity is 1,000 cfs, with the ability to withstand short-duration flows up to 1,500 cfs. The barrier is designed to overtop at about 1,500 cfs flow from the San Joaquin River, while flows greater than 1,750 cfs will submerge the barrier. However it is also influenced by backwater due to its proximity to the Merced River confluence. For example, the barrier overtops when Merced River flows are at 2,000 cfs, or when both rivers are flowing at approximately 800 cfs.

The Hills Ferry Barrier has not been operated in the spring when juvenile salmon and steelhead are emigrating from the downstream tributaries. The opportunity for these juveniles to access the San Joaquin River upstream of the Merced River has been extremely low due to inhospitable water flow and water quality conditions. However, Interim and Restoration flows likely will provide conditions that could allow emigrating juvenile salmon and steelhead to stray upstream of the Merced River. The need to maintain a barrier at Hills Ferry during the spring is to be evaluated by DFG as part of the SJRRP fishery investigations. As previously described, the Proposed Action would comply with any future operational criteria at any diversion points utilized for recapture of Interim or Restoration flows, which could include changes in the operation of the Hills Ferry Barrier, screening of diversion points, or cessation of recapture at times when presence of juvenile salmon or steelhead are anticipated in the vicinity of the diversion facilities.

3.3.3 Vernalis Adaptive Management Program

The Merced, Tuolumne, and Stanislaus rivers are the three main tributaries to the San Joaquin River. Releases from major reservoirs on these tributaries are made in response to multiple operational objectives, including flood management, downstream diversions, instream fisheries flows, instream water quality flows, and releases to meet water quality and flow objectives at Vernalis as part of requirements under Water Right Decision 1641 (D-1641) including the Vernalis Adaptive Management Program (VAMP). VAMP was an experimental program to determine how salmon survival rates change in response to alterations in flow releases (primarily from tributary reservoirs), and alterations in CVP/SWP export levels that are based on flow conditions in the San Joaquin River at Vernalis.

VAMP expired in 2010. In February 2011, the SJRGA issued a Notice of Intent to Adopt a Negative Declaration (ND) for the One-Year Extension of the SJRA in 2011. This would allow for a pulse flow for a 31-day period at Vernalis during April and May, with the exact timing determined by the San Joaquin River Technical Committee. Further, this action would identify other flows through the Central Valley Project Improvement Act (CVPIA) water acquisition plan, with concurrence by USFWS, to facilitate migration and attraction of anadromous fish, including fall attraction flows and other flows needed by the adaptive management study.

Reclamation is working with the SJRGA to implement a VAMP-like action for 2011. Although the NMFS 2009 *Final Biological and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS CVP/SWP Operations BO) states that agreements for VAMP-like conditions will be pursued, the future of VAMP is uncertain, and Reclamation and SJRA participants are discussing the future approach for a VAMP-like action beyond 2011.

The SWRCB issued a Revised Notice of Preparation on April 2, 2011 for the review of the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary. This includes the review and update of water quality objectives, including flow objectives, and the program of implementation of the Bay-Delta Plan. The environmental documents that will be prepared by the SWRCB will: establish narrative flow objectives to support migratory fish populations for the San Joaquin river and the tributaries to the San Joaquin River: the Stanislaus, Tuolumne, and Merced Rivers; meet the narrative objectives by providing flow conditions that approximate the timing and magnitude of natural flows, from 20 percent to 60 percent of natural flows, depending on the assessment of the competing uses for water; a proposed implementation framework that recognizes the need and use of adaptive management for flow needs; establishing southern Delta salinity objectives and narrative water level and circulation objectives to protect agricultural uses in the Delta; and a program of implementation to achieve salinity and circulation objectives.

No decisions on the future of a VAMP-like action have been made at the time of preparation of this BA. Reclamation is continuing negotiations for the near-term with the SJRGA. However, because of the requirements in the 2009 NMFS CVP/SWP Operations BO and because of the reasonably foreseeable modifications proposed by the SWRCB on the 2006 Water Quality Control Plan for the San Francisco Bay/Sacramento-San Joaquin Delta Estuary, it is reasonable to assume that a VAMP-like action would occur in the future. Reclamation would operate within all existing regulatory requirements related to future VAMP-like actions.

3.3.4 NMFS and USFWS Operations Biological Opinions

On December 15, 2008 the USFWS issued the *Biological Opinion (BO) on the Coordinated Operations of the CVP and SWP* (2008 USFWS CVP/SWP Operations BO). The 2008 USFWS CVP/SWP Operations BO concluded that the proposed CVP/SWP project operations were likely to jeopardize the continued existence of delta smelt (USFWS 2008). USFWS developed a reasonable and prudent alternative (RPA) to: (1) reduce/prevent entrainment of delta smelt at Jones and Banks pumping plants; (2) provide adequate habitat conditions for migration and spawning in the Delta; (3) provide adequate habitat for larval and juvenile rearing; and (4) provide habitat suitable for successful recruitment of juvenile delta smelt to adulthood.

On June 4, 2009, NMFS issued the 2009 NMFS CVP/SWP Operations BO. The 2009 NMFS CVP/SWP Operations BO concluded that the proposed operations were likely to jeopardize the continued existence of the following:

- Sacramento River winter-run Chinook salmon
- Central Valley spring-run Chinook salmon
- Central Valley steelhead
- Southern distinct population segment of North American green sturgeon
- Southern resident killer whales

The 2009 NMFS CVP/SWP Operations BO stated that the CVP and SWP have "both directly altered the hydrodynamics of the Sacramento-San Joaquin River basins and have interacted with other activities affecting the Delta to create an altered environment that adversely influences salmon and green sturgeon population dynamics. The altered environment includes changes in habitat formation, species composition, and water quality, among others" (NMFS 2009). The opinion further concluded that the CVP/SWP operations are not likely to jeopardize the continued existence of Central California Coast steelhead. NMFS developed an RPA in accordance with ESA requirements. NMFS indicated that based on the analyses presented in the biological opinion that the "RPA cannot and does not, however, include all steps that would be necessary to achieve recovery." Consequently, NMFS included focused actions designed to compensate for a particular stressor (NMFS 2009).

Reclamation provisionally accepted the BOs and respective RPAs. Several urban and agricultural water suppliers have filed suit challenging the BOs, and these lawsuits are currently pending. If conditions change as challenges to the BOs move forward, Reclamation will comply with the regulations and legal requirements in place at that time.

On March 25, 2010, NMFS issued a determination that Reclamation's anticipated operations, as shown in the figures and tables within that memorandum, were consistent with specific actions of the RPA. The Proposed Action would be operated to comply with the BOs and any applicable RPAs, or requirements as amended by court action. The RPAs included in the BOs address conditions within the Stanislaus River and downstream that affect the Central Valley steelhead DPS, and conditions within the Delta that affect the steelhead DPS, the southern DPS of North American green sturgeon, the winter-run and the spring-run Chinook salmon ESUs, and delta smelt. The recapture of Interim or Restorations flows under the Proposed Action at existing Delta facilities would be subject to existing or future consultations concerning the operation of those facilities, and the effects of those facilities on listed species is addressed through those consultations.

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Chapter 4.0
Environmental Baseline

Consistent with ESA, the effects analysis presented in this BA compares the Proposed Action under consideration to the environmental baseline. As previously described, the environmental baseline is defined, for purposes of this analysis, as the existing conditions in place at the time when the NOP for the Draft PEIS/R was published (August 22, 2007). This is equivalent to the existing conditions evaluated in the Draft PEIS/R, and does not include the release of Interim Flows, which began in October 2009. This chapter describes the historical and baseline conditions, as well as the habitat types found in the Action Area and the current management direction of existing and ongoing Federal, State, and local efforts intended to protect Federally listed and proposed species in the Action Area.

4.1 Historical Conditions

Typical of Central Valley rivers and a semiarid climate, the natural or “unimpaired” flow regime of the San Joaquin River historically varied greatly in the magnitude, timing, duration, and frequency of streamflows, both interannually and seasonally. Variability in streamflows created conditions that partially helped sustain multiple salmonid life history strategies, as well as life history phases of numerous resident native fish species and other aquatic species.

The San Joaquin River originates in the Sierra Nevada at an elevation greater than 11,000 feet above mean sea level. It rapidly descends and exits mountainous terrain in the area now occupied by Friant Dam. The first few miles of the river downstream from the current location of Friant Dam is a deeply incised channel that discharges to the valley floor near Gravelly Ford. Before the influx of settlers after the Civil War in the 1860s and the subsequent agricultural development, the San Joaquin River and its main tributaries in their natural state meandered across alluvial fans along the main axis of the San Joaquin Valley floor. The river distributed higher flows into a complex network of sloughs that branched off both sides of the river. It flowed through a flat, homogeneous topography and supported a limited riparian forest. The flat valley floor surrounding the riparian forest often took the form of extensive wetlands, dominated by tule marsh. Riparian forest zones were present along the margins of the primary river channel and were not extensive (The Bay Institute 1998).

The frequency and distribution of habitat types and microhabitat features present in the San Joaquin River before the construction of Friant Dam were substantially different from those currently found in the river. In the reach downstream from the current location of Friant Dam, braided channels and side channels were likely important spawning areas and provided high-quality rearing habitat for fry and juveniles (McBain and Trush 2002).

In the unconfined valley reaches, the river flowed through an extensive flood basin that was frequently subject to prolonged inundation, particularly during the spring snowmelt-runoff period.

This description of historic conditions for the three major tributaries of the San Joaquin River – the Merced, Tuolumne, and Stanislaus rivers – is based on reconstructions developed for the Tuolumne River by McBain and Trush (2000). The Tuolumne is the largest of the three main San Joaquin River tributaries, but conditions in all three were likely broadly similar because the tributaries are geographically close and drain geologically and hydrologically similar watersheds. Because dams were constructed on these rivers, the lower sections of the rivers are the only portions still accessible to anadromous salmonids.

The natural flow regimes of the Merced, Tuolumne, and Stanislaus rivers historically resulted in much greater variation in the magnitude of streamflows than the current regulated flow regimes. In the Tuolumne River, flow within a given year and between years varied from as little as 100 cfs in summer to peak winter floods exceeding 100,000 cfs. Before flows and sediment were regulated, the channel bed and banks were composed of gravel, cobble, and boulders, and the flow regime and sediment supply were adequate to form and maintain the bed and bank morphology. Before flows were regulated, variability in hydrologic and geological controls, as well as large floods, bedload transport, and channel migration, created dynamic, complex local channel morphologies and diverse riparian vegetation. These processes consistently renewed and maintained high-quality aquatic and terrestrial habitat in the lower reaches of the Merced, Tuolumne, and Stanislaus rivers.

In the lowermost sections of these tributaries, riparian corridors were miles wide. These corridors were sand-bedded and supported lush riparian vegetation. Diversity in plant communities was maintained by a dynamic interaction between the initiation, maturation, and mortality of plant stands. Upstream from the Merced River confluence, natural streambanks along the mainstem San Joaquin River were poorly developed because sediment loads were relatively low, which led to development of vast tule marshes along the river (McBain and Trush 2002).

Near Mendota, the San Joaquin River merged with Fresno Slough, a wider and deeper waterway than the San Joaquin River. Fresno Slough was part of an intricate slough system that exchanged water between the Tulare Lake Basin and the San Joaquin River. Downstream from Mendota, the San Joaquin River flowed through a network of large slough channels traversing extensive riparian woodland, tule marshes, and backwater ponds until it joined with the Merced River. Downstream from this point, the floodplain was more confined, and the river exhibited a highly sinuous pattern of rapid channel meander, which created a rich complex of oxbow lakes, backwater sloughs, ponds, and sand bars. In its lower sections just upstream from the Delta, the river formed low natural levees approximately 6 feet high (The Bay Institute 1998).

Habitat conditions in and along the mainstem San Joaquin River downstream from the Merced River confluence, however, were likely similar to those of the lowermost sections of the three primary tributaries. The Merced, Tuolumne, and Stanislaus rivers supplied the sediments required for the formation of relatively stable low- and high-flow channels in the downstream stretch of the San Joaquin River. Those natural streambanks helped provide the conditions required for development of riparian forests like those on the lower sections of the tributaries. Downstream from the Stanislaus River confluence, closer to the Delta, the San Joaquin River was again bordered by extensive tule marsh.

Although historic water quality data (i.e., data from before construction of Friant Dam) are not available, the rivers presumably provided excellent water quality conditions for native fish, including anadromous salmonids. Cold, clear snowmelt runoff flowing from the granitic upper basins of the southern Sierra Nevada provided optimal conditions for freshwater life-history stages of salmonids in the upper San Joaquin River and its tributaries and for invertebrate production, the primary food resource for salmonids. The abundant cold water in the upper San Joaquin River basin presumably had high (saturated) concentrations of dissolved oxygen (DO), low salinity, and neutral pH levels. Levels of suspended sediment and turbidity were likely low, even during high runoff events, because of the upper basin’s mainly granitic geology and the relatively low rates of primary productivity (algae growth).

The Delta is a 600-square-mile area of channels and islands at the confluence of the Sacramento and San Joaquin rivers (Lund et al. 2007). Freshwater draining from a 41,300-square-mile watershed enters the Delta from the Sacramento and San Joaquin rivers and several smaller rivers. This Delta is fundamentally different from other river deltas because it was not formed primarily from deposition of river sediments but from a combination of river sediments and vast quantities of organic matter deposited by tules and other marsh plants. Accumulation of both types of sediments has kept pace with a slow rise in sea level over the past 6,000 years.

The historical Delta consisted of low-lying islands and marshes. As originally found by European explorers, nearly 60 percent of the Delta was submerged by daily tides, and spring tides could submerge it entirely. Although most of the Delta was a tidal wetland, the water in the interior remained primarily fresh. However, inflow to the Delta from its major tributaries was much more variable than the current regulated flow regime, and salinity intruded much farther inland in the Delta during summer in some years. Inflow in winter and spring was generally higher than under current conditions. Approximately 350,000 acres of freshwater marsh were present in the Delta before land reclamation efforts began soon after the start of the Gold Rush. The dominant vegetation was tules, but a variety of tree species was established on the natural levees, including oak, sycamore, alder, walnut, and cottonwood.

4.2 Baseline Conditions

The lower San Joaquin River and the valley sections of its major tributaries – the Merced, Tuolumne, and Stanislaus rivers – have changed dramatically since the early part of the 19th century. These rivers are now largely confined within constructed levees and bounded by agricultural and urban development, flows are regulated by dams and water diversions, and floodplain habitats have been fragmented and reduced in size and diversity (McBain and Trush 2002). As a result, the riparian communities have substantially changed from historic conditions (McBain and Trush 2000; Jones and Stokes Associates 1998a). The presence of Friant Dam on the San Joaquin River and a series of dams on the eastside tributaries reduce the frequency of scouring flows, resulting in a gradual decline of bare gravel and sandbar surfaces, which are required to recruit growth of new riparian plants.

The largest dam on the Merced River is New Exchequer Dam, which forms Lake McClure (1 million acre-feet). Downstream from New Exchequer Dam is Crocker-Huffman Dam, which prevents further upstream migration of anadromous salmonids. The valley section of the Merced River is characterized by abandoned floodplain terraces (USFWS 2001a), which have been developed for agricultural uses, such as row crops, cattle grazing, and orchard crops. Because riparian vegetation has been removed to facilitate these agricultural practices, only a narrow strip of riparian vegetation remains along the incised river channel. The riparian habitat and floodplain have been further disturbed by intensive aggregate mining.

The largest reservoir on the Tuolumne River is New Don Pedro Reservoir (2.0 million acre-feet). Several small reservoirs lie downstream from this reservoir, the lowermost of which is Modesto Reservoir. La Grange Dam, immediately downstream from Modesto Reservoir, is the upstream barrier to migration of anadromous salmonids.

Mining activities and urban and agricultural encroachment on the Tuolumne River directly removed large tracts of riparian vegetation, and selective grazing by livestock removed young riparian plants. Regulation of flow and sediment indirectly affected riparian vegetation by modifying the hydrologic and fluvial processes required for a dynamic riparian ecosystem.

The largest dam on the Stanislaus River is New Melones Dam (2.4 million acre-feet). Goodwin Dam, downstream from New Melones Dam, is the upstream barrier for anadromous salmonid migration on the Stanislaus River. Alteration of the natural flow regime and changes in land use practices similar to those described for the Merced and Tuolumne rivers have adversely affected environmental conditions in the lower Stanislaus River.

Delta habitat has been severely affected by the combined effect of many past and present actions. More than 95 percent of the Delta’s original tidal marshes have been leveed and filled, resulting in losses of aquatic habitat (U.S. Geological Survey (USGS) 2007). The current Delta consists of islands, generally below sea level, that are surrounded by levees to keep water out. Inflow of freshwater into the Delta has been substantially reduced by water diversions, mostly to support agriculture. Dredging and other physical changes have altered flow patterns and salinity levels (USGS 2007).

The south Delta is perhaps the most degraded portion of the Delta because of large water diversions at Federal and State export facilities located in this region, greatly reduced inflow from the San Joaquin River, and high levels of contaminants from agricultural drainage. Nonnative species have changed and are continually changing the Delta's ecology by altering its food webs. All the habitat changes have had substantial effects on the Delta's biological resources, including marked declines in the abundance of many native fish and invertebrate species (Greiner et al. 2007). Native fish species in decline include delta smelt, green sturgeon, Central Valley fall-run and spring-run Chinook salmon, Sacramento River winter-run Chinook salmon, and Central Valley steelhead.

Federal and State wildlife preserves have been established to conserve, protect, and enhance migratory waterfowl habitat and native ecological communities of the San Joaquin Valley. The preserves furnish important native habitats, including valley oak and mixed riparian forests and seasonal and permanent wetlands, to support and benefit wildlife species, particularly those of special concern. Land preserves in or adjacent to the Restoration Area are shown in Figure 4-1.

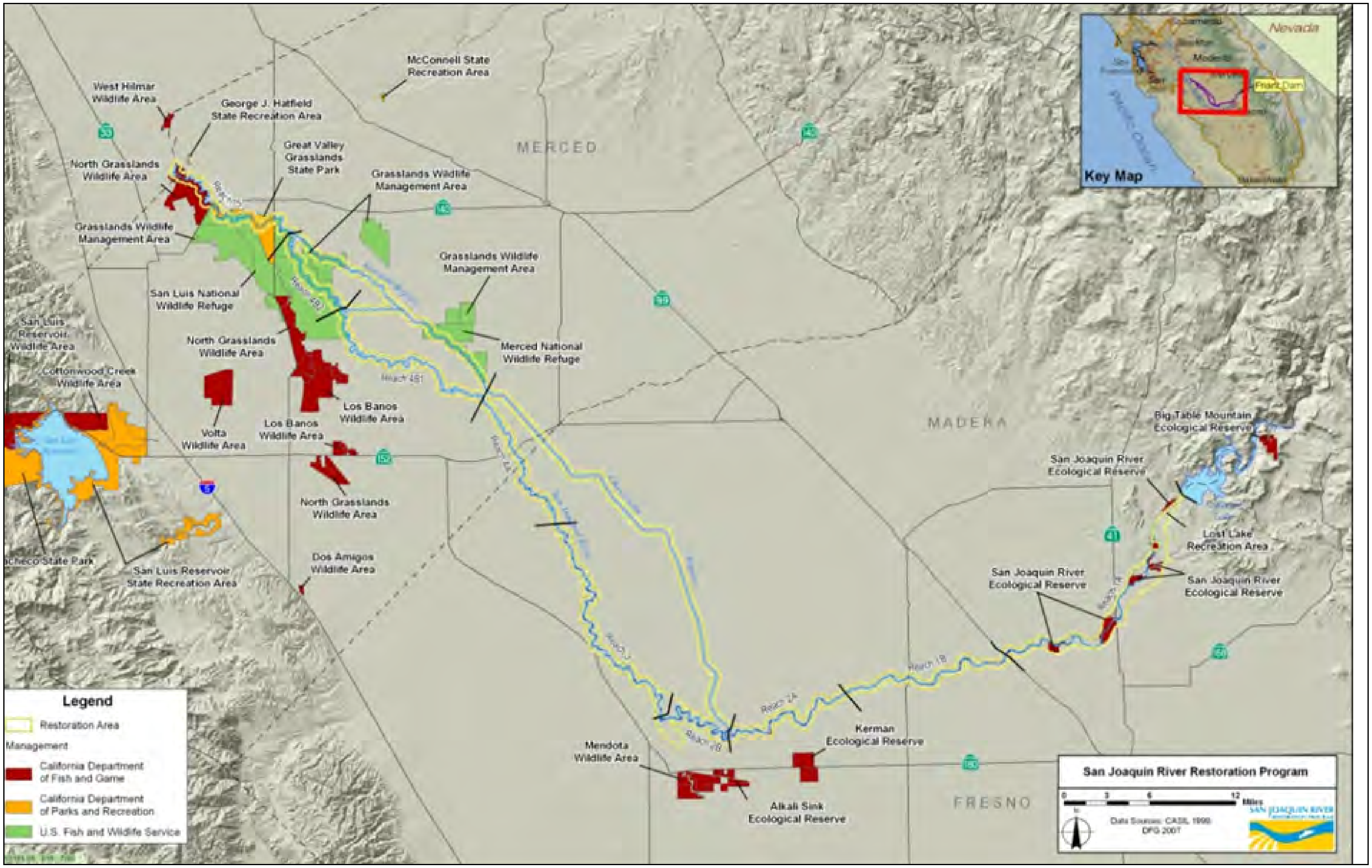

Figure 4-1.
Land Preserves in the Action Area

4.3 Habitat Types in the Action Area

There are two general categories of habitat types in the Action Area – aquatic and terrestrial – both of which are described below.

4.3.1 Aquatic Habitat Types

The Action Area encompasses a large variety of aquatic habitats. A 9-mile reach of the San Joaquin River stretches upstream from Millerton Lake to Kerckhoff Dam. This section of river has a bedrock-constrained channel with alternating long, narrow pools and small cascades, poorly developed riparian vegetation, and flow managed by diversions and releases from Kerckhoff Dam. Millerton Lake and the San Joaquin River upstream from Millerton Lake do not support any listed aquatic species, so this region is not discussed further in this section.

Numerous monitoring and data collection activities have been conducted to further assess aquatic habitat in the San Joaquin River downstream from Friant Dam. The Fisheries Management Plan (FMP) identified numerous targeted studies, monitoring, and actions to assess and address fisheries conditions in the San Joaquin River (Reclamation 2011a). The Annual Technical Reports (ATR) describe ongoing monitoring activities and pilot studies in the San Joaquin River between Friant Dam and the confluence of the Merced River, including those related to the FMP, conducted by DWR, Reclamation, USGS, USFWS, and DFG (Reclamation 2011a and 2011b). These reports include data and descriptions of streamflows, water surface elevations, water temperatures, water quality, suspended sediments, and other fisheries conditions associated with salmonid life cycle, fish passage, and fish habitat. Where appropriate, these data are used in Chapter 6.0, "Effects," to inform the analysis of the potential effects of the Proposed Action.

Monitoring activities exclusively for fisheries during spring 2010 Interim Flows included an inventory of fish habitat by boat, deployment of hyporheic pots to collect information relevant to egg survival in the riverbed, and a fish barrier assessment. Results from these efforts are currently not available. Meso-habitat surveys were also conducted by DFG to map riverine habitat, the results of which are in the 2010 ATR, but are not directly tied to the quality of fish habitat.

The 2010 ATR presented water quality monitoring results for compounds that could have potential effects on Chinook salmon and other fish native to the San Joaquin River. Prominent findings included concentrations of bifenthrin in sediment samples with the potential to cause mortality in certain organisms and bioaccumulate up the food web, and 30 water quality samples with copper exceeding the EPA aquatic-life acute benchmark for invertebrates. Report recommendations included monitoring stormwater inflow for toxic concentrations, using tissue samples or semi-permeable membranes to investigate bioaccumulation, and using more advanced laboratory tools to detect sub-lethal constituent concentrations that affect fish behavior and life cycles (Reclamation 2011b).

The section of San Joaquin River between Friant Dam and the Merced River confluence (i.e., Reaches 1A through 5) provides generally poor fish habitat conditions, although

Reach 1 does contain more suitable habitat, including spawning habitat, as most recently documented by Reclamation in a study of the substrate environment in Reach 1A (Reclamation Technical Service Center 2011). Physical barriers, reaches with poor water quality or no surface flow, and the presence of false migration pathways have reduced habitat connectivity. Habitat complexity between Friant Dam and the confluence with the Merced River is reduced, with limited side channel habitat or instream habitat structure and highly altered riparian vegetation. In upstream portions, gravel mining has created pits that provide lentic habitat that may be used by piscivorous species. Bypasses in these reaches receive water sporadically, as necessary for flood control. Most aquatic habitat in the bypasses is therefore temporary, and its duration depends on flood flows; the bypasses are largely devoid of aquatic and riparian habitat because of efforts to maintain hydraulic conveyance for flood flows (McBain and Trush 2002). Because of the infrequency of flows in the bypasses, most existing habitat in the bypasses is terrestrial and is therefore discussed in Section 4.3.2, "Terrestrial Habitat."

The Chowchilla Bypass Bifurcation Structure regulates the flow split between the San Joaquin River and Chowchilla Bypass. The Chowchilla Bypass extends to the confluence of Ash Slough and is approximately 22 miles long, leveed, and 600 feet to 700 feet wide. Sand deposits are dredged from the bypass as needed, and vegetation is periodically removed from the channel.

The Eastside Bypass circumvents 32.5 miles of river and extends from the confluence of Ash Slough and the Chowchilla Bypass to the confluence with the San Joaquin River. The Eastside Bypass is subdivided into three reaches:

- Reach 1 extends from Ash Slough to the Sand Slough Bypass confluence. This reach receives flows from the Chowchilla River.
- Reach 2 extends from Sand Slough Bypass to the head of the Mariposa Bypass.
- Reach 3 extends from the head of the Mariposa Bypass to the San Joaquin River. This reach receives flows from Deadman, Owens, and Bear creeks.

The Merced River is accessible to anadromous fish for the first 51 river miles upstream from the San Joaquin River confluence, with access terminating at Crocker-Huffman Dam (USFWS 2001). The 10 miles of the Merced River between Crocker-Huffman Dam – the current barrier for fish passage – and SR 59 are where most Chinook salmon and steelhead spawning occurs. This reach has moderate flow and is confined by piles of dredger tailings and sparse riparian vegetation. Gravel mining pits are common for approximately 20 miles. The middle stretch of river (approximately 18 miles) is a low-gradient, meandering, and levee-confined system in a narrow corridor, often isolated from its floodplain. The lower 8 miles of the Merced River are sand-bedded, with the most extensive and continuous stand of native riparian vegetation in the river.

The Tuolumne River provides roughly 52 miles of waterway accessible to anadromous salmonids. Aquatic habitats in the Tuolumne River downstream from La Grange Dam are influenced by several factors, many of them related to former gold mining activities and gravel mining (McBain and Trush 2000). A 10-mile stretch of the Tuolumne River channel downstream from the dam is constrained by extensive fields of dredge tailings that range from large cobbles to fine sediments, which restrict river meander and access to alluvial sediments. Downstream, the lower gradient river meanders through low hills and valleys bordered by grazing land, tree crops, and irrigated fields of row crops. At approximately 25 miles below La Grange Dam, the river is generally channelized and flows through sandy loam soils. In this lower reach, the Tuolumne River channel is characterized by slow-velocity run habitat with a sandy-silty bottom and no riffles; the area is not suitable for salmonid spawning.

In the Stanislaus River, fall-run Chinook salmon spawn in a 23-mile stretch of the Stanislaus downstream from Goodwin Dam, but most spawning occurs in the first 10 miles below the dam. Aquatic habitats in the lower Stanislaus River vary longitudinally and provide fish spawning, rearing, and/or migratory habitat for a diverse assemblage of common Central Valley native and nonnative fish species. Aquatic habitats consist of riffles, runs, pools, and glides. Floodplain and associated riparian habitat vary with the presence of levees and encroachment of agricultural and urban uses.

Habitat conditions in the lower San Joaquin River downstream from the Merced River confluence are similar to those described above for the lowermost section of the Tuolumne River. The river channel is characterized by slow-velocity run habitat with a sandy-silty bottom and no riffles. Riparian habitat is poorly developed. Diversions are numerous in this section, providing water for agricultural and municipal use; some of the applied water is returned as agricultural drainage (Brown and May 2006).

The portion of the Action Area farthest downstream is the south Delta, which provides highly modified estuarine habitat. Little remains of the tidal marshes that once provided vast amounts of aquatic habitat. Current habitat consists primarily of a complex network of interconnected and leveed channels. Vegetation on the levees of some channels provides suitable riparian habitat, but other levees are armored with riprap, which has little value for fish habitat. Water development projects have greatly altered the seasonal magnitude, timing, and direction of flows in the Delta, which has adversely affected native species and may have facilitated successful invasions by numerous exotic species. Exotic species dominate the Delta’s biotic community.

The Delta is a tidal region, and every 12.4 hours, the tides cause water to move in and out of the Delta (USFWS 2008). Most of the time, tides cause a 5- to 8-mile ebb-and-flow movement of water in the western part of the Delta. The movement of freshwater through the Delta is superimposed on the tidal flows. Typical freshwater flows are much smaller than tidal flows, usually in the range of 5 percent to 15 percent of the tidal flows. Along a salinity gradient extending from San Francisco Bay into the Delta, the species composition of the aquatic community changes dramatically, although the basic functional relationships among organisms (e.g., predator/prey) remain similar throughout the system.

4.3.2 Terrestrial Habitat Types

The regional vegetation and land cover types in the Action Area are described below.

Millerton Lake and Upper San Joaquin River to Kerckhoff Dam

Plant communities around Millerton Lake are mostly foothill woodlands and grassland, with minor inclusions of willow scrub along the shoreline and riparian forest communities where intermittent drainage channels empty into the lake. Adjacent hillsides support foothill pine–blue oak woodland with abundant grass/forb and shrub understory. Open grassland and savanna-type habitat conditions also exist in some areas. Several large basalt tables known to have vernal pools surround the canyon, with elevations ranging from 1,450 feet to 2,000 feet. Upland vegetation above Millerton Lake is characterized by foothill pine–oak woodland with areas of open grassland and rock outcroppings. The predominant vegetation is foothill pine, blue oak, and interior live oak. Montane coniferous forest constitutes the higher elevations upstream from Mammoth Pool. Habitat types in this area are meadow, riparian deciduous, lodgepole pine, mixed conifer, ponderosa pine, rock outcrop, and brush (Upper San Joaquin River Water and Power Authority (USJRWPA) 1982).

San Joaquin River from Friant Dam Downstream to Merced River

Reach 1. Steep bluffs confine the riparian zone for much of Reach 1A (DWR 2002). Reach 1A supports continuous riparian vegetation, except where the channel has been disrupted by instream aggregate removal or off-channel aggregate pits that have been captured by the river. This subreach has the highest overall diversity of plant species in the Restoration Area and greatest number of riparian communities: cottonwood, willow, mixed, and oak riparian forest; willow and riparian scrub and elderberry savanna; and emergent wetland (DWR 2002). Large areas occupied by invasive tree species (blue gum and tree-of-heaven) have been recorded in Reach 1A. Giant reed and red sesbania were also recorded (DWR 2002).

Reach 1B is more narrowly confined by levees. Outside of the levees and steep bluffs, land uses are nearly all agricultural. Woody riparian vegetation is prevalent and occurs mainly in narrow strips immediately adjacent to the river channel. Mature vegetation on the backside of many point bars and on low floodplains is scarce. Remnant valley oaks are present on some of the higher terraces. Previously cleared terraces and the understory of the cottonwood and oak stands are dominated by nonnative annual grasses (McBain and Trush 2002). Blue gum, giant reed, red sesbania, and tree-of-heaven are prevalent in Reach 1B. Red sesbania was mapped downstream to River Mile 242 in 2000 but likely is more abundant downstream given its potential to spread rapidly (DWR 2002).

Reach 2. Reach 2 of the San Joaquin River is characterized by seasonal drying of the channel in summer and fall. The water table recedes into the porous substrate, creating a pronounced riparian drought nearly every year (DWR 2002). In most years, the channel is essentially dry most of the year from Gravelly Ford to the Mendota Pool, except under flood release conditions, when up to 2,000 cfs is passed downstream from the Chowchilla Bifurcation Structure (Jones and Stokes Associates 1998b). Cultivated lands occupy nearly all the lands outside the river bottom.

Riparian vegetation in the upper 10 miles of this reach (Reach 2A) is sparse or absent because the river is usually dry and the shallow groundwater is overdrafted (McBain and Trush 2002). Grassland and pasture are relatively abundant in Reach 2A, contributing almost 50 percent to the total natural land cover (excluding urban and agricultural land cover types). The most abundant riparian communities present are riparian and willow scrub habitats. The only significant stand of elderberry savanna mapped in the Restoration Area occurs on the left bank near the Chowchilla Bifurcation Structure, at the junction of Reaches 2A and 2B (DWR 2002). Invasive species recorded in Reach 2A in 2000 included large stands of blue gum and tree-of-heaven (9 acres) and giant reed (6 acres) (DWR 2002). Red sesbania is also widespread in Reach 2A, based on observations made in 2008.

The lower few miles of Reach 2B support narrow, patchy, but nearly continuous vegetation because this area is continuously watered by the backwater of the Mendota Pool. The riparian zone is narrowly confined to a thin strip 10 to 30 feet wide bordering the channel. The herbaceous understory, however, is rich in native species, and a high portion of the total vegetative cover is native plants. Invasive species were not mapped in Reach 2B by DWR (2002).

The margins of the Mendota Pool support areas of emergent vegetation dominated by cattails and tules; a few cottonwoods and willows grow above the waterline.

Reach 3. San Joaquin River Reach 3 is characterized by continuous flow from the Delta-Mendota Canal within a confined channel, by seasonally low water, and by narrow strips of riparian vegetation along the river’s edge. Adjacent lands are mostly in agricultural use, except where the city of Firebaugh borders the river’s west bank for 3 miles. The likely reason that the riparian corridor is narrow is that the upper and middle floodplain elevations have been developed for agricultural and urban uses. A reduction in the frequency of lower flood events also likely resulted in less frequent scouring, which has decreased the abundance of early successional riparian vegetation (e.g., scrub) and riverwash (Jones and Stokes Associates 1998b), while allowing the establishment of riparian forest.

Nearly continuous riparian vegetation of various widths and cover types occurs on at least one side of the channel in this reach. In Reach 3, cottonwood riparian forest is the most abundant native vegetation type, followed by willow scrub, willow riparian forest, and riparian scrub. Small amounts (less than 0.5 acre each) of giant reed and nonnative trees were mapped in Reach 3 (DWR 2002).

Reach 4. Reach 4A San Joaquin River is similar to Reach 3 in that the flow is confined within a narrow channel, and agricultural land borders the levees. The flows in this subreach are usually negligible because of the diversion at Sack Dam, but flood control flows periodically are conveyed in such a way as to define a channel through the reach (Jones and Stokes Associates 1998b). The floodplain of Reach 4B is broader, with levees set back from the active channel. The water table is also closer to the surface than in the other reaches within the Restoration Area (DWR 2002).

Reach 4A is sparsely vegetated, ranging from a thin band of vegetation to none along the channel margin. Willow scrub and willow riparian forest occur in small to large stands, and ponds rimmed by small areas of marsh vegetation are present in the channel; however, this reach has the fewest habitat types and lowest ratio of natural vegetation per river mile in the Restoration Area.

Reach 4B upstream from the Mariposa Bypass (Reach 4B1) supports a nearly unbroken, dense, but narrow corridor of willow scrub or young mixed riparian vegetation on most of the reach, with occasional large gaps in the canopy. Reach 4B1 no longer conveys flows because the Sand Slough Control Structure diverts all flows into the bypass system.

As a result, the channel in Reach 4B1 is poorly defined and filled with dense vegetation; in some cases, it is plugged with fill material.

Because of its wider floodplain and available groundwater, and because the land is managed as part of the San Luis NWR, Reach 4B2 contains vast areas of natural vegetation compared to the upstream reaches. Grasslands and pasture are the most common vegetation type, but willow riparian forest and emergent wetlands are also relatively abundant. Agricultural land uses are greatly reduced relative to other reaches in the Restoration Area (DWR 2002).

Reach 5. Conditions in Reach 5 of the San Joaquin River are similar to conditions in Reach 4B2. The floodplain is broad, less agricultural conversion of natural habitat has occurred than elsewhere in the Restoration Area, and land is held in public ownership and managed for wildlife habitat. The river has more sinuosity in this reach, and oxbows, side channels, and remnant channels are present; however, the floodplain and basin are generally disassociated from the mainstem river because of levees constructed as part of the San Joaquin River Flood Control System (McBain and Trush 2002).

In Reach 5, the San Joaquin River is surrounded by large expanses of upland grassland, with substantial woody riparian vegetation in the floodplain. Remnant riparian tree groves are concentrated on the margins of mostly dry secondary channels and depressions or in old oxbows. Along the mainstem San Joaquin River, a relatively uniform pattern of patchy riparian canopy hugs the channel banks as large individual trees or clumps (primarily valley oak or black willow) with a mostly grassland or brush understory (McBain and Trush 2002).

The most abundant plant community is grassland and pasture, followed by willow riparian forest, emergent wetland, willow and riparian scrub, and willow, oak, and cottonwood riparian forests. Alkali scrub is also present in this reach (DWR 2002).

Eastside and Mariposa Bypasses

Eastside Bypass. Upland vegetation in the Eastside Bypass is grassland and ruderal vegetation (i.e., herbaceous vegetation and predominantly nonnative vegetation associated with disturbed lands). The reach between the Sand Slough Control Structure and the Merced NWR (approximately 4.5 miles) supports several ponds. For the next 2.2 miles, the bypass moves through the Merced NWR, encompasses more than 10,000 acres of wetlands, native grasslands, vernal pools, and riparian habitat. Farther downstream, the Eastside Bypass passes through the Grasslands Wildlife Management Area, an area of private lands with conservation easements held by USFWS, and through the East Bear Creek Unit of the San Luis NWR Complex. Patchy riparian trees and shrubs occur along the banks of the Eastside Bypass in these areas. Side channels and sloughs (e.g., Duck, Deep, and Bravel sloughs) are present along the lower Eastside Bypass, and some support remnant patches of riparian vegetation.

Mariposa Bypass. The Mariposa Bypass is bordered by agricultural land on the south and by vernal pool grasslands on the north. Scattered riparian trees are present along the bypass.

San Joaquin River Downstream from the Merced River Confluence

The San Joaquin River downstream from the Merced River confluence is similar to the river upstream from the confluence, except that the Merced, Tuolumne, and Stanislaus rivers contribute a substantial amount of flow in this area. The upstream portion of the San Joaquin River below the Merced River is more incised than the downstream portion, with generally drier conditions in the riparian zone and a less developed understory. Agricultural land use has encroached on the riparian habitat along most of the San Joaquin River. Along much of the river, only a narrow ribbon of riparian habitat is supported. However, riparian habitat is more extensive locally, especially near the confluence with tributary rivers; within cutoff oxbows; and in the 6,500-acre San Joaquin River NWR, located between the confluences with the Tuolumne and Stanislaus rivers. Remnant common tule- and cattail-dominated marshes may occur in these areas.

Sacramento-San Joaquin Delta

Agriculture dominates the Delta area, with agricultural lands occupying nearly three-quarters of the region’s total land area (CALFED 2000). However, a substantial area of natural vegetation remains, including large areas of sensitive riparian, marsh, and aquatic vegetation, which are described below. Most riparian vegetation in the Delta is characterized by narrow, linear strips of trees and shrubs in single-story to multistory canopies. Tree canopies may be continuous, discontinuous, or absent altogether (as in riparian scrub). These patches of riparian vegetation typically are on or at the toe of levees. Riparian communities in this region include cottonwood-willow woodland, valley oak riparian woodland, riparian scrub, and willow scrub.

In addition to the wetland communities described for the San Joaquin River, the Delta supports tidal freshwater and brackish water emergent marshes that, like nontidal marshes, are dominated by clonal perennial plants. This community occurs on instream islands and along most tidally influenced waterways. In addition to the environmental factors affecting marshes outside of the Delta, the species composition of tidal marshes in the Delta is affected by regional salinity gradients.

The Delta supports extensive areas of aquatic vegetation. These communities consist of submerged plants generally rooted in the substrate that have stems that may extend partially above the water surface (e.g., during flowering) and floating plants that generally are not rooted in the substrate. The availability of light (which decreases with depth), turbidity, water velocities, and shade cast by overtopping vegetation can restrict submerged plants to relatively shallow areas. In the Delta (which has turbid waters), most submerged vegetation appears to be restricted to areas between 5 and 10 feet deep.

Merced, Tuolumne, and Stanislaus Rivers

As mentioned previously, three major rivers are tributary to the San Joaquin River: the Merced, the Tuolumne, and the Stanislaus. These rivers were evaluated for habitat from the respective dam sites to the confluence with the San Joaquin River: the Merced River downstream from New Exchequer Dam, the Tuolumne River downstream from Don Pedro Dam, and the Stanislaus River downstream from New Melones Dam. These rivers originate in the Sierra Nevada foothills and are generally surrounded by foothill pine-oak woodland with an herbaceous understory. As the rivers reach the floor of the Central Valley, urban development and agricultural land uses cause the riparian corridor to become narrower.

Along the Merced River, near the community of Snelling, dredge spoils line the river. The dredge spoils support seasonal scrub–shrub wetlands in the concave areas between spoils. Downstream, a wide wash is present along the Merced River floodplain; this area is devoid of woody vegetation, and two oxbow lakes are present in this area. Dredge spoils are also present along the Tuolumne River, near the community of La Grange. The dredge spoils in this location support forested wetlands throughout the spoils area. In addition, dredge spoils are present along the Stanislaus River and support a forested wetland habitat.

4.4 Current Management Direction

The Proposed Action has been developed around existing and ongoing Federal, State, and local efforts intended to protect Federally listed and proposed species in the Action Area. Consultation with USFWS and NMFS regarding the potential effects of the Proposed Action is based on the ESA policy for each resource agency, existing BOs, and other guidance documents and programs.

4.4.1 Central Valley Project Improvement Act

The CVPIA amends the authorization of the CVP to include fish and wildlife protection, restoration, and mitigation as project purposes of the CVP having equal priority with irrigation and domestic uses of CVP water and elevates fish and wildlife enhancement to a level having equal purpose with power generation. Under the CVPIA, a significant goal identified to meet the new fish and wildlife purposes is the broad goal of restoring natural populations of anadromous fish (Chinook salmon, steelhead, green and white sturgeon, American shad and striped bass) in Central Valley rivers and streams to double their recent average levels.

4.4.2 Anadromous Fish Restoration Program

The Anadromous Fish Restoration Program (AFRP) was developed to comply with Section 3406(b)(1) of the CVPIA. The Secretary of the Interior was directed to:

> *"…develop within three years of enactment and implement a program which makes all reasonable efforts to ensure that, by the year 2002, natural production of anadromous fish in Central Valley rivers and streams will be sustainable, on a long-term basis, at levels not less than twice the average levels attained during the period of 1967–1991…"*

Additionally, Section 3406(b)(1) jointly imparted the responsibilities of implementing the CVPIA to USFWS and Reclamation although USFWS has assumed the lead role in the development of the AFRP. The Final Restoration Plan for the AFRP was adopted on January 9, 2001, and will be used to guide the long-term development of the AFRP.

4.4.3 Long-term Central Valley Project and State Water Project Operations Criteria and Plan

The CVP and the SWP are two major inter-basin water storage and delivery systems that divert and re-divert water from the southern portion of the Delta. Both CVP and SWP include major reservoirs upstream of the Delta, and transport water via natural watercourses and canal systems to areas south and west of the Delta. The CVP also includes facilities and operations on the Stanislaus and San Joaquin rivers. The major facilities on these rivers are New Melones and Friant dams, respectively.

The projects are permitted by the SWRCB to store water during wet periods, divert water that is surplus to the Delta, and re-divert CVP/SWP water that has been stored in upstream reservoirs. Both CVP and SWP operate pursuant to water right permits and licenses issued by the SWRCB to appropriate water by diverting to storage or by directly diverting to use and re-diverting releases from storage later in the year. As conditions of their water right permits and licenses, SWRCB requires the CVP and SWP to meet specific water quality, quantity, and operational criteria within the Delta. Reclamation and DWR closely coordinate the CVP and SWP operations, respectively, to meet these conditions.

Because the CVP and SWP operations, including export activities, affect fish and wildlife in the Central Valley, Reclamation consulted with both USFWS and NMFS under Section 7 of the ESA. As described in Reclamation's 2008 *Biological Assessment on the Continued Long-term Operations of the Central Valley Project and the State Water Project* (CVP/SWP Operations BA), while part of the CVP, the Friant Division operations were not included in the action for the purposes of Section 7 consultation on CVP/SWP Operations. This separation was practical because, prior to implementation of the Settlement, the Friant Division was generally hydrologically disconnected from the Delta, except in extremely wet years. Implementation of the Settlement was not included in the consultation because "…it is a large project which has not been sufficiently developed to allow for analysis of the effects of implementation of settlement action on listed aquatic species at this time." The CVP/SWP Operations BA acknowledges that, "At some point in the future, consultation may need to be reinitiated to evaluate the effects of the Restoration Program on continued CVP and SWP operations" (Reclamation 2008).

USFWS completed the BO for delta smelt in 2008 (USFWS 2008), while NMFS completed the BO for Central Valley steelhead DPS, Sacramento River winter-run Chinook salmon ESU, Central Valley spring-run Chinook salmon ESU, and the southern DPS of the North American green sturgeon in 2009 (NMFS 2009a). The USFWS 2008 *Biological Opinion on the Coordinated Operations of the CVP and SWP* (2008 USFWS CVP/SWP Operations BO) and NMFS 2009 *Final Biological and Conference Opinion on the Long-Term Operations of the CVP and SWP* (2009 NMFS CVP/SWP Operations BO) identify reasonable and prudent alternatives (RPAs) to the proposed action that are intended to avoid the likelihood of jeopardy to the species and adverse modification of designated and proposed critical habitat. The RPAs do not address operations of Friant Dam.

In March 2009, CVP and SWP contractors filed three separate lawsuits in Federal Court challenging the 2008 USFWS CVP/SWP Operations BO. On May 4, 2011, Judge Oliver Wanger issued an amended judgment in the litigation challenging the USFWS 2008 CVP/SWP Operations BO for delta smelt. Judge Wanger required USFWS to prepare a new BO and NEPA compliance document on the effects of the new BO by December 2013. In the interim, CVP and SWP operations will be controlled by the current delta smelt BO, unless Judge Wanger issues rulings authorizing alternative operations.

Given the uncertainty in how the RPA requirements will be implemented in the future, it is not appropriate to reinitiate consultation on the effects of CVP/SWP operations with the SJRRP in place. However, as the RPAs are a significant change in the operational environment of the CVP/SWP, it is necessary to provide an assessment of the potential effects of the SJRRP under the requirements of the 2008 USFWS BO and the 2009 NMFS BO on CVP/SWP operations. For the purposes of the SJRRP Programmatic BA, sensitivity analyses were performed to support evaluation of the potential for a comprehensive range of RPA implementations to significantly change the effects determinations from those presented in the SJRRP Programmatic BA. These simulations were then used to define an outer boundary of potential effects of implementing the Proposed Action under any final implementation of the RPAs. These simulations are not intended to represent Reclamation-suggested RPA implementations or Reclamation policy in any form. Use of these simulations outside of this sensitivity analysis does not represent Reclamation policy and may be misleading or factually incorrect. At some point in the future, section 7 consultation may need to be reinitiated to evaluate the effects of continued CVP and SWP operations with the SJRRP in place.

4.4.4 CALFED Bay-Delta Program

CALFED consists of a consortium of Federal and State agency personnel working together to protect the San Francisco Bay/Sacramento-San Joaquin Delta, coordinate CVP and SWP operations, and develop a long-term Bay-Delta solution to address ecosystem restoration. A major element of the CALFED Bay Delta Program is the Ecosystem Restoration Program Plan that is intended to provide the foundation for long-term ecosystem and water quality restoration and protection throughout the region.

4.4.5 Coordinated Operations Agreement

The 1985 Agreement between the United States of America and DWR for Coordinated Operation of the CVP and SWP, or Coordinated Operations Agreement (COA), defines the rights and responsibilities of the CVP and SWP with respect to in-basin water needs and provides a mechanism to measure and account for those responsibilities. In-basin uses are defined in the COA as legal uses of water required under SWRCB Decision 1485 (D-1485), Delta Standards. Since both the CVP and SWP utilize the Delta as common conveyance facilities, reservoir releases and Delta export operations must be coordinated to ensure that the CVP and SWP each retains its share of the commingled water and each bears its share of the joint obligations to protect beneficial uses.

Balanced water conditions are defined in the COA as periods when it is agreed that releases from the upstream reservoirs, plus unregulated flows, approximately equals the water supply needed to meet Sacramento Valley in-basin demands plus exports. Excess water conditions are periods when sufficient water is available to meet all beneficial needs, and the CVP/SWP are not required to make releases from reservoir storage. When water must be withdrawn from reservoir storage under the COA, the CVP is responsible for providing 75 percent and the SWP 25 percent of the water to meet Delta Standards. When unstored water is available for export (i.e., under balanced conditions), and the sum of CVP stored water, SWP stored water, and the unstored water for export is allocated at 55/45 percent to the CVP and SWP, respectively.

Operations of the CVP/SWP have evolved considerably since 1986 with changes to facilities and operating criteria. New flow standards such as those imposed by the SWRCB have revised how projects are operated. Although the burden of meeting these new responsibilities has been worked out internally between the CVP and SWP, the COA has never been officially amended or evaluated for consistency in the evolved operations.

4.4.6 Recovery Plan for Sacramento-San Joaquin River Delta Native Fishes

In 1996, USFWS released the *Recovery Plan for Sacramento-San Joaquin River Delta Native Fishes* (USWFS 1996) that included recovery plans for delta smelt, spring-run Chinook salmon, San Joaquin River fall-run Chinook salmon and green sturgeon. The objective of the Recovery Plan is to establish self-sustaining populations of the fishes that will persist indefinitely.

4.4.7 Recovery Plan for Anadromous Salmonids

In 2009, NMFS published the *Draft Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of the Central Valley Steelhead* (NMFS 2009b). This draft recovery plan is considered necessary to improve the viability of these species in order to remove them from the need for protection under the ESA. It provides a roadmap that includes steps, strategies and actions that would reintroduce these species to ensure their long-term persistence and evolutionary potential. The SJRRP is identified in the draft recovery plan as a necessary action to assist in the recovery of spring-run Chinook salmon.

4.4.8 Watershed Protection Program

In 1997, the Watershed Restoration and Protection Council (WRPC) program was established and is composed of all California agencies that have programs addressing anadromous salmonid protection and restoration. The WRPC is charged with overseeing all State activities aimed at watershed protection and enhancement, and directing the development of a Watershed Protection Program that provides for anadromous salmonid conservation in California.

4.4.9 Habitat Conservation Plans

NMFS and USFWS are currently assisting in the development of multiple species habitat conservation plans (HCP) for State and privately owned lands. HCPs, which are required under Section 10 of the ESA, address species protection under non-Federal projects. The purpose of the HCP is to ensure that any incidental taking of listed species will not appreciably reduce the likelihood of species survival, and to help contribute to the species recovery.

4.4.10 Clean Water Act and Rivers and Harbors Act

Projects requiring a permit from the USACE, under Section 10 of the Rivers and Harbors Act of 1899 and Section 404 of the Clean Water Act (CWA) do not allow the extent of destruction and modification of sensitive species' habitat that occurred prior to the implementation of these regulations. Measures to protect sensitive species are often included as "standard measures" in Section 404 permits. Examples of these measures include eliminating or reducing siltation by installing silt fencing along project sites and access roads, preventing sensitive species from entering the project area, erecting cofferdams on either side of project sites, and timing project activities to reduce impacts during the breeding season.

4.4.11 Pacific Coast Salmon Fishery Management Plan

The Pacific Fishery Management Council (PFMC) regulates the offshore sport and commercial fishery for Chinook salmon using its *Pacific Coast Salmon Fishery Management Plan* (PFMC 2003), which describes the goals and methods for salmon management. Management tools, such as season length, quotas, bag limits, and gear restrictions, vary annually, depending on how many salmon are present. There are two main components to the plan: (1) an annual goal for the number of spawners of the major salmon stocks ("spawner escapement goals") and (2) allocation of the harvest among different groups of anglers (commercial, recreational, tribal, various ports, ocean, and inland). PFMC must also comply with laws such as the ESA.

4.4.12 California Endangered Species Act

The CESA of 1984 is administered by DFG to protect fish and wildlife resources by regulating the listing and "take" of endangered and threatened species. A "take" of such a species may be allowed by DFG through issuance of permits pursuant to Fish and Game Code Section 2081. DFG is empowered to review projects for their potential impacts to listed species and their habitats.

CESA is similar to the Federal ESA but pertains only to State-listed endangered and threatened species. CESA requires State agencies to consult with DFG when preparing documents under CEQA to ensure that the actions of the State lead agency do not jeopardize the continued existence of listed species. CESA directs agencies to consult with DFG on projects or actions that could affect listed species, directs DFG to determine if jeopardy to listed species would occur, and allows DFG to identify “reasonable and prudent alternatives” to the project consistent with conserving the species. Agencies can approve a project that affects a listed species if the agency determines that there are “overriding considerations”; however, the agencies are prohibited from approving projects that would cause the extinction of a listed species. CESA prohibits the “take” of plant or wildlife species listed by the State as endangered or threatened. DFG may authorize take if there is an approved habitat management plan or management agreement that avoids or compensates for impacts on listed species.

4.4.13 The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act

The Salmon, Steelhead, Trout and Anadromous Fisheries Program Act was enacted in 1988. At that time, DFG reported that the natural production of salmon and steelhead in California had declined to approximately 1,000,000 adult Chinook salmon, 100,000 coho salmon, and 150,000 steelhead. In addition, DFG reported that the naturally spawning salmon and steelhead resources of the State had declined dramatically within the past four decades primarily as a result of lost stream habitat on many streams in the State. The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act declares that it is the policy of the State to increase the salmon and steelhead resources, and directs DFG to develop a plan and program that strives to double the salmon and steelhead resources (Fish and Game Code Section 6900).

4.4.14 Steelhead Restoration and Management Plan of California

The State’s goals for steelhead restoration and management outlined in *Steelhead Restoration and Management Plan for California* (McEwan and Jackson 1996) are: (1) to increase natural production, as mandated by The Salmon, Steelhead Trout, and Anadromous Fisheries Program Act of 1988, in an attempt to create self-sustaining steelhead populations and maintain them in good condition; and (2) to enhance opportunities for angling and non-consumptive uses.

The plan focuses on the restoring of native and wild stocks, as these stocks have the greatest value insofar as maintaining genetic and biological diversity. Suggested strategies to accomplish these two goals include restoring degraded habitat; restoring access to historic habitat that is currently blocked; reviewing angling regulations to ensure that steelhead adults and juveniles are not over-harvested; maintaining and improving hatchery runs, where appropriate; and developing and facilitating research to address deficiencies in information on freshwater and ocean life history, behavior, habitat requirements, and other aspects of steelhead biology.

4.4.15 Porter-Cologne Act

The Porter-Cologne Act, enacted in 1969 and amended in 2005, specifies requirements for water quality protection in California. Under the Porter-Cologne Act, California is required to adopt water quality policies, plans, and objectives that ensure beneficial uses of the State are reasonably protected. SWRCB and the RWQCB are the agencies with the primary responsibilities of water quality protection and Clean Water Act implementation in California. In their respective regions, the RWQCBs engage in several water quality functions. One of the most important is preparing and periodically updating water quality control plans, which specify the beneficial uses to be protected within a particular region. RWQCBs also regulate all pollutant or nuisance discharges that may affect either surface water or groundwater, including non-point source discharges to surface water. Additionally, the SWRCB, in acting on water rights applications, may establish terms and conditions in water rights permits to help implement water quality control plans.

Chapter 5.0
Species Accounts

This chapter presents the status, habitat requirements, and potential for occurrence of each species evaluated in this BA. In addition, critical habitat is discussed for each species that has been designated and could be affected by the Proposed Action. Recovery and management actions important to the conservation of species are also summarized from existing recovery plans or other information, when available.

5.1 Aquatic Species

Listed aquatic species protected under the ESA and described below are the Central Valley steelhead DPS, Central Valley spring-run Chinook salmon ESU, Sacramento River winter-run Chinook salmon ESU, southern DPS of North American green sturgeon, delta smelt,. For each species, the discussions below describe the species' historic and current distribution, abundance trends, life history, and factors affecting the species and critical habitat. Also described below are effects to Central Valley fall-run Chinook salmon under EFH compliance.

5.1.1 Central Valley Steelhead Distinct Population Segment

The Central Valley steelhead DPS includes all naturally spawned populations of anadromous steelhead below natural and human-made impassable barriers in the Sacramento and San Joaquin rivers and their tributaries, excluding steelhead from San Francisco and San Pablo bays and their tributaries. This DPS also includes anadromous steelhead from artificial propagation programs operated at the Federal Coleman National Fish Hatchery and State Nimbus and Feather River fish hatcheries. Central Valley steelhead DPS is listed as threatened (71 Federal Register (FR) 834–862, January 5, 2006). Critical habitat was designated for the Central Valley steelhead DPS in 2006 (70 FR 52488 – 52627, September 2, 2005).

"Steelhead" is the term commonly used for the anadromous form of rainbow trout. NMFS has considered including resident *Oncorhynchus mykiss* in listed steelhead DPSs in the following cases (63 FR 13347 – 13371, March 19, 1998):

- Where resident *O. mykiss* have the opportunity to interbreed with anadromous fish below natural or artificial barriers.

- Where resident fish of native lineage once had the ability to interbreed with anadromous fish, but no longer do because they are currently above artificial barriers and are considered essential for the recovery of the DPS.

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However, USFWS, which has authority over resident fish under the ESA, concluded that behavioral forms of *O. mykiss* can be regarded as separate DPSs; without evidence that resident rainbow trout need ESA protection, only anadromous forms should be included in the DPS and listed under the ESA. USFWS also did not believe that the recovery of steelhead would rely on the intermittent exchange of genetic material between resident and anadromous forms. In the final rule, the listing includes only the anadromous form of *O. mykiss* (63 FR 13347–13371, March 19, 1998).

Moreover, NMFS considers all *O. mykiss* that have physical access to the ocean (including resident rainbow trout) to potentially be steelhead and will treat these fish as steelhead. Microchemical analyses of otoliths taken from rainbow trout in the San Joaquin River Basin have verified that the anadromous form of *O. mykiss* occurs in low numbers in the basin (Zimmerman et al. 2008).

NMFS published a draft recovery plan for all listed Central Valley salmonids, including Central Valley steelhead (NMFS 2009b). The following measures have been identified for the protection of Central Valley steelhead:

- Conduct and improve monitoring and research on distribution, status, and trends.
- Protect and restore the complexity of watershed and estuarine habitat.
- Implement freshwater habitat restoration techniques as part of construction activities (e.g., construction of setback levees, bar stabilization, and levee repair and maintenance; reintroduction of instream woody material (IWM); and erosion control).
- Reduce and control impacts of urbanization through education and outreach, partnerships, collaborative teams, and protective regulations.
- Screen water diversion structures in important/high-priority anadromous fish-bearing streams.
- Collaboratively balance water supply and allocation with the needs of fisheries by improving criteria for water drafting, storage and dam operations, and water rights programs; developing passive diversion devices and/or offstream storage; eliminating illegal diversions in priority watersheds and streams; and facilitating other such opportunities.
- Modify channel and flood control maintenance practices, where appropriate, to increase stream and riparian complexity.
- Identify and treat point- and nonpoint-source pollution in streams caused by wastewater, agricultural practices, and urban environments.

Historic and Current Distribution

The historic distribution of steelhead in the Central Valley is not known, but in rivers where the species still occurs, steelhead are normally more widely distributed than Chinook salmon (Voight and Gale 1998; Yoshiyama et al. 1996). Steelhead typically spawn in tributaries of the main rivers.

Lindley et al. (2006) predicted the historical distribution of steelhead, using an Intrinsic Potential habitat model. They found that at least 81 independent populations of *O. mykiss* were widely distributed throughout the Central Valley, but that populations were relatively less abundant in San Joaquin River tributaries than in Sacramento River tributaries because of natural barriers to migration. Also, many small tributaries to the major San Joaquin River tributaries have too high a gradient or too little flow to have supported *O. mykiss*; consequently, steelhead were likely restricted to the mainstems and larger tributaries (Lindley et al. 2006). Around 80 percent of the historical spawning and rearing habitat is now behind impassable dams, and 38 percent of the populations identified by the model have lost their entire habitat (Lindley et al. 2006).

Naturally spawning steelhead populations have been found in the upper Sacramento River downstream from Keswick Dam; in Mill, Deer, and Butte creeks; and in the Feather, Yuba, American, and Mokelumne rivers (McEwan 2001). The steelhead population in the San Joaquin River was extirpated; however, small populations of steelhead persist in the lower San Joaquin River tributaries (i.e., the Stanislaus and Tuolumne rivers and possibly the Merced River) and in the Calaveras River (McEwan 2001). Naturally spawning populations may exist in many other streams without being detected because of the lack of monitoring or research programs in those streams. Steelhead also rear in and migrate through the Delta.

Abundance Trends

NMFS has concluded that populations of naturally reproducing steelhead have been experiencing a long-term decline in abundance throughout their range. Populations in the southern portion of the range have experienced the most severe declines, particularly in streams from the Central Valley south, where many stocks have been extirpated (NMFS 2009b). Since the early 20th century, 23 naturally reproducing populations of steelhead are believed to have been extirpated in the western United States. Many more are thought to be in decline in Washington, Oregon, Idaho, and California. The decline of stocks in California has been particularly steep.

The historic run size of Central Valley steelhead is difficult to estimate given limited data, but may have approached 1million to 2 million adults annually; by the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). In the past 30 years, populations of naturally spawned steelhead in the upper Sacramento River have declined substantially. The number of adult steelhead in the Sacramento River upstream from the Feather River was estimated to average 20,540 through the 1960s (Hallock et al. 1961, as cited in McEwan and Jackson 1996; NMFS 2009a). Steelhead counts at Red Bluff Diversion Dam (RBDD) declined from an average of 11,187 for the period of 1967–1977 to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on

RBDD counts, of no more than 10,000 adults (McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 because of changes in dam operations (NMFS 2009a).

The only limited data available on steelhead numbers in the San Joaquin River Basin come from DFG midwater trawling samples collected on the lower San Joaquin River at Mossdale. These data suggest that steelhead numbers declined in the early 1990s and remained low through 2002 (NMFS 2009a). However, the sampling is part of another survey targeting Chinook salmon smolts. Trawling efficiency rates for the Chinook salmon smolts were as low as 1 to 2 percent, suggesting that only a small fraction of steelhead was captured. Population numbers of adult Central Valley steelhead present in the San Joaquin River tributaries (Stanislaus, Tuolumne, and Merced rivers) are unknown.

Life History

Steelhead exhibit highly variable patterns throughout their range, but are broadly categorized into winter- and summer-run reproductive ecotypes. Winter-run steelhead, the most widespread reproductive ecotype, become sexually mature in the ocean, enter spawning streams in fall or winter, and spawn in winter or late spring (Meehan and Bjornn 1991; Behnke 1992). In the Sacramento River, juvenile steelhead generally emigrate as 2-year-olds (Hallock et al. 1961, cited in McEwan and Jackson 1996) in winter and spring (McEwan 2001). Emigration appears to be more closely associated with size than with age; most downstream migrants measure 6 inches to 8 inches. Downstream migration in unregulated streams has been correlated with spring freshets (Reynolds et al. 1993).

Adult Upstream Migration and Spawning. In the Central Valley, adult winter-run steelhead migrate upstream during most months of the year. Upstream migration begins in June, peaks in September, and continues through February or March (Hallock et al. 1961, Bailey 1954, both as cited in McEwan and Jackson 1996). Spawning occurs primarily from January through March, but may begin as early as late December and may extend through April (Hallock et al. 1961, cited in McEwan and Jackson 1996). In the Central Valley, adult winter steelhead generally return at ages 2 and 3 and range in size from 2 to 12 pounds (Reynolds et al. 1993). Increased water temperatures may trigger movement, but some steelhead ascend into freshwater without any apparent environmental cues (Barnhart 1991).

Although most steelhead die after spawning, adults are capable of returning to the ocean and migrating back upstream to spawn in subsequent years. Runs may include 10 to 30 percent repeat spawners, most of which are females (Ward and Slaney 1988; Meehan and Bjornn 1991; Behnke 1992). Repeat spawning is more common in smaller coastal streams than in large watersheds that require a lengthy migration (Meehan and Bjornn 1991). Hatchery steelhead are typically less likely than wild fish to survive to spawn a second time (Leider et al. 1986). In the Sacramento River, 14 percent of the steelhead return to spawn a second time (Hallock 1989). Steelhead may migrate downstream to the ocean immediately after spawning or may spend several weeks holding in pools before outmigrating (Shapovalov and Taft 1954).

Egg Incubation, Alevin Development, and Fry Emergence. Eggs hatch after incubating 20 days to 100 days, depending on water temperature (Shapovalov and Taft 1954; Barnhart 1991). Newly hatched steelhead alevins (yolk-sac larvae) remain in the gravel for an additional 14 days to 35 days while being nourished by their yolk sacs (Barnhart 1991). Upon emergence, fry inhale air at the stream's surface to fill their air bladders, absorb the remains of their yolks, and start to feed actively, often in schools (Barnhart 1991; NMFS 2009b). Survival from egg to emergent fry is typically less than 50 percent (Meehan and Bjornn 1991) but may be quite variable, depending upon local conditions.

Juvenile Freshwater Rearing. Juvenile steelhead (parr) rear in freshwater before outmigrating to the ocean as smolts. The time that parr spend in freshwater appears to be related to growth rate, with larger, faster-growing members of a cohort smolting earlier (Peven et al. 1994). Steelhead in warmer areas, where feeding and growth are possible throughout the winter, may require a shorter period in freshwater before they smolt, while steelhead in colder, more northern, and inland streams may require 3 or 4 years before smolting.

Juveniles typically remain in their natal streams for at least one summer, dispersing from fry schools to establish feeding territories (Barnhart 1991). Peak feeding and freshwater growth rates occur in late spring and early summer. Juveniles either overwinter in their natal streams, if adequate cover exists, or disperse to other streams as presmolts to seek more suitable winter habitat (Bjornn 1971; Dambacher 1991). When stream temperatures fall below about 45 degrees Fahrenheit (°F) in the late fall to early winter, steelhead enter a period of winter inactivity spent hiding in the substrate or closely associated with instream cover, during which time growth ceases (Everest and Chapman 1972). Juveniles' winter hiding behavior reduces their metabolism and food requirements and reduces their exposure to predation and high flows (Bustard and Narver 1975), but substantial mortality still appears to occur in winter.

Smolt Outmigration and Estuarine Rearing. Steelhead migrate downstream to the ocean as smolts, typically at a length of 5.85 inches to 7.80 inches (Meehan and Bjornn 1991). A length of 5.46 inches is typically cited as the minimum size for smolting (Wagner et al. 1963; Peven et al. 1994). Emigration appears to be more closely associated with size than with age; 6 to 8 inches is the most common size of downstream migrants. Downstream migration in unregulated streams has been correlated with spring freshets (Reynolds et al. 1993). However, evidence suggests that photoperiod is the most important environmental variable that stimulates the physiological transformation from parr to smolt (Wagner 1974). During smoltification, the spots and parr marks characteristic of juvenile coloration are replaced by a silver and blue-green iridescent body color (Barnhart 1991), and physiological transformations occur that allow steelhead to survive in salt water.

Less is known about the use of estuaries by steelhead than about use by other anadromous salmonid species; however, available data show that in many systems, steelhead use estuaries as rearing habitat (NMFS 2009a). Estuarine rearing may be more important to steelhead populations in the southern half of the species' range because of greater variability in ocean conditions and the paucity of high-quality nearshore habitats in this portion of their range (Bond 2006). Estuaries may also be more important to populations that spawn in smaller coastal tributaries because of the more limited availability of rearing habitat in the headwaters of smaller stream systems (McEwan and Jackson 1996).

Most marine mortality of steelhead occurs soon after the fish enter the ocean; predation is believed to be the primary cause of this mortality (Pearcy 1992, cited in McEwan and Jackson 1996). Predation mortality and fish size are likely to be inversely related (Pearcy 1992, cited in McEwan and Jackson 1996); therefore, the growth that takes place in estuaries may be very important for increasing the odds of marine survival (Shapovalov and Taft 1954; McEwan and Jackson 1996; Bond 2006; NMFS 2009b).

Steelhead have variable life histories. They may migrate downstream to estuaries as age 0+ juveniles or may rear in streams for up to 4 years before outmigrating to the San Francisco estuary and ocean (Shapovalov and Taft 1954). Juvenile steelhead may rear in the estuary for 1 month to 6 months before entering the ocean (Barnhart 1991). Several studies have shown that estuaries provide valuable rearing habitat to juvenile and yearling steelhead, and are not merely a corridor for smolts migrating to the ocean (McEwan and Jackson 1996; Bond 2006).

Ocean Phase. Most steelhead spend 1 year to 3 years in the ocean, and smaller smolts tend to remain in salt water longer than larger smolts (Chapman 1958; Behnke 1992). Larger smolts have been found to experience higher ocean survival rates (Ward and Slaney 1988). Steelhead grow more rapidly in the ocean than in freshwater rearing habitats (Shapovalov and Taft 1954; Barnhart 1991). Unlike other salmonids, steelhead do not appear to form schools in the ocean. Steelhead in the southern part of the species' range appear to migrate close to the continental shelf, and more northern populations may migrate throughout the northern Pacific Ocean (Barnhart 1991).

Factors Affecting the Distinct Population Segment and Critical Habitat

Environmental factors most likely to affect the abundance and distribution of the Central Valley steelhead DPS are discussed below.

Flow. Reservoir operations and diversions have altered the natural flow regime of Central Valley streams by changing the frequency, magnitude, and timing of flows. These changes may affect all steelhead life stages. Inadequate instream flows caused by water diversions reduce available habitat and may lead to high water temperatures. Rapid flow fluctuations caused by water conveyance needs and flood control operations may strand redds and young fish.

For steelhead spawning to be successful, flows must provide appropriate water depths and velocities over suitable spawning gravels. Pool tailouts or heads of riffles with well-oxygenated gravels are often selected for redds (Shapovalov and Taft 1954). Flow also influences water temperature, which is a critical habitat factor for egg incubation (see below).

Suitable flows are necessary year-round for juvenile rearing. After they emerge from spawning gravels in spring or early summer, steelhead fry move to shallow-water, low-velocity habitats such as stream margins and low-gradient riffles, and forage in open areas that lack instream cover (Hartman 1965; Everest et al. 1986; Fontaine 1988). As the fry grow, they increasingly use areas with cover, showing a preference for flows with higher velocities. Older juvenile steelhead occupy a wide range of hydraulic conditions. A high flow level increases the habitat area available to juvenile steelhead because they commonly use submerged terrestrial vegetation on the edge of the channel and within the floodplain. Greater flow increases average depth, which improves protection from avian and terrestrial predators (Everest and Chapman 1972). In broad low-gradient rivers, changes in flow levels can greatly increase or decrease the lateral area available to juvenile steelhead, particularly in riffles and shallow glides.

The stream reaches that are presently accessible to steelhead often lack the summer habitat conditions needed to sustain juvenile steelhead through their freshwater rearing period (NMFS 2009a). These conditions can be exacerbated by reservoir operations and water diversions that reduce summer flows, and can be particularly severe in drought years.

Water Temperature. Water temperature is a primary limiting factor for natural steelhead production on many Central Valley streams (NMFS 2009a). Although many dams provide downstream releases for fall-run Chinook salmon, most do not provide cool temperatures for steelhead during summer and fall, especially during extended droughts (Moyle et al. 2008). Many dams are not able to provide cool water because they were not designed for deep-water reservoir releases or they lack adequate pool storage (McEwan 2001). Where releases of cold water occur throughout the summer, resident populations of trout often develop, supporting fisheries that may affect steelhead.

Spawning Gravels. Egg incubation success (egg hatching and fry emergence) is highly dependent on flow, water temperature, and levels of DO surrounding the developing embryos. Spawning gravels provide the conditions that promote reproductive success by steelhead. Barnhart (1986) reported gravels with high permeability and few fines (less than 5 percent sand and silt by weight) in highly productive steelhead spawning streams. Moyle (2002) reported that steelhead redds are constructed primarily in riffles that consist of coarse gravels. Most natural production of steelhead occurs in tributaries to the upper Sacramento River because spawning in the mainstem river is limited by the paucity of smaller gravel (Reynolds et al. 1990).

Dams have reduced or prevented the recruitment of spawning-size gravel to downstream riffles. Riffles downstream from dams are anticipated to continue to degrade as flood flows move gravel downstream without providing replenishment from upstream areas. Superimposition of redds may occur when spawning gravels are insufficient, leading to reduced spawning success.

Bank Modification and Loss of Riparian Habitat. Nearshore aquatic and riparian habitats in many Central Valley rivers have been degraded by the loss of riparian vegetation and streambank modification resulting from agricultural conversion, levee construction and maintenance, channelization, bank protection, and other land use activities. Such degradation has occurred along the middle and lower reaches of the Sacramento River and its major tributaries and the eastside tributaries of the San Joaquin River. Riparian vegetation along the Sacramento River is highly fragmented, constituting less than 50 percent of its historical extent (California Resources Agency 1989). An inventory of river's-edge riparian habitat along the lower Sacramento River and Delta channels indicated a 22 percent to 26 percent reduction in such habitat since 1972, most of which was attributed to bank protection activities (California Resources Agency 1989). Riparian forest along the Tuolumne River is estimated to constitute less than 15 percent of its original extent (McBain and Trush 2000).

Dam construction, streambank modifications, removal of riparian vegetation, and other watershed activities have led to an overall decrease in the amount of IWM input into the riverine systems. IWM plays a variety of important ecological roles. The quality and quantity of fish habitat are directly enhanced by the presence of IWM, which provides overhead cover and additional instream structure (Lisle 1986; Everett and Ruiz 1993). Benefits of IWM in streams include retention of organic debris, such as salmon carcasses (i.e., nutrient retention); creation of cover between redds; and creation of additional habitat for aquatic macroinvertebrates, a major component of fish diets. The abundance of salmonids is often positively associated with the abundance of IWM in a river (Bisson et al. 1987; Hartman and Brown 1987). In streams, IWM creates a diversity of hydraulic gradients that increases microhabitat complexity, especially beneficial for the early life stages of salmonid species.

Shaded riverine aquatic habitat, defined as the nearshore aquatic area at the interface between a river and adjacent woody riparian habitat, provides high-value feeding areas, escape cover, and reproductive cover for numerous fish species, including steelhead (USFWS 1992a as cited in Fris and Dehaven 1993). Riparian vegetation and other features of naturally eroding streambanks provide high-value rearing habitat for juvenile steelhead. Overhanging vegetation and banks moderate local water temperatures and provide shade, direct inputs of food (primarily terrestrial insects), and cover from predators.

Because of its unique biological attributes and its increasing scarcity throughout the Sacramento River system, shaded riverine aquatic cover has been designated as Resource Category 1, which is defined as "unique and irreplaceable on a national basis or in the ecoregion" (USFWS 1992 as cited in Fris and Dehaven 1993). A Category 1 designation requires project proponents to actively seek impact avoidance and mitigation measures that result in no loss of existing habitat value.

Delta Exports and Entrainment. Water diversions reduce the survival levels of emigrating juvenile steelhead by causing direct losses at unscreened or inadequately screened diversions and indirect losses associated with reduced streamflows. Fish screening and salvage efforts at major agricultural diversions have met with variable levels of success, and many smaller unscreened or inadequately screened diversions continue to operate. Fish losses at diversions can result from physical injury, impingement, entrainment, or predation. Delayed passage and increased stress also contribute to mortality caused by diversions. Impacts of diversions on anadromous fish depend on diversion timing and magnitude, river discharge, life stage, and other factors.

Diversions in the Delta entrain juvenile steelhead (Reclamation 2008a). The CVP and SWP export facilities in the south Delta have fish screens used to salvage fish greater than a certain size (believed to be about 20 millimeters), but many of the salvaged fish are assumed not to survive their return to the Delta (Kimmerer 2004). Losses at the facilities have been shown to contribute to recent declines of steelhead (Reclamation 2008a). Diversions reduce fitness not only by resulting in mortality from entrainment, but also by changing flow patterns that affect levels of straying by upstream-migrating adults and outmigrating smolts.

Hatchery Operations. Four hatcheries in the Central Valley – Coleman National Fish Hatchery, Feather River Fish Hatchery, Nimbus Fish Hatchery, and Mokelumne River Hatchery – raise steelhead, producing an average of 1.5 million yearlings per year (McEwan 2001). Hatchery production can negatively affect fish populations by leading to a loss of genetic integrity primarily through hybridization, inbreeding, and random genetic change (drift). Hybridization presumably creates individuals that are less well-adapted to local conditions than either parent. Inbreeding results from the breeding of closely related individuals, and is likely to develop from hatchery production because eggs and milt are obtained from relatively few individuals. A small breeding population may also lead to genetic drift. Both inbreeding and genetic drift can lead to the production of individuals that are less well-adapted than naturally produced fish to the natural environment in which the species evolved.

The following are other potentially negative effects of producing hatchery fish:

- Displacement of wild steelhead juveniles through competition and predation
- Competition of hatchery adults with wild adults for limited spawning habitat
- Stimulation of sport and/or commercial harvest efforts, which could increase the harvest rate of naturally produced steelhead
- An increase in the rate of disease among naturally produced fish
- Negative social interaction between hatchery steelhead and wild steelhead

These first two effects are well-documented for salmonids and may explain why only an estimated 10 percent to 30 percent of returning steelhead in the upper Sacramento River are of wild origin (Reynolds et al. 1990).

Altered Pathways for Adult and Juvenile Migration Through the Delta. Central Valley steelhead adults migrate upstream through the Delta primarily from June through February or March (Hallock et al. 1961, Bailey 1954, both as cited in McEwan and Jackson 1996). Steelhead smolts emigrate through the Delta toward the ocean in spring, with migrations peaking during April and May. The Sacramento and San Joaquin rivers provide the most direct routes for adult migration through the Delta. When adult or juvenile steelhead stray from these channels, their migrations are delayed, and their exposure to stressful habitat conditions (e.g., warm water temperatures, predation, inadequate food resources) may increase.

Sacramento River water may be transported into the lower San Joaquin River via the Delta Cross Channel (DCC), Georgiana Slough, and Threemile Slough, and at the confluence of the Sacramento and San Joaquin rivers. The following factors affect the proportion of Sacramento River water drawn into the lower San Joaquin River:

- Diversions from and inflow to the Delta east of the Sacramento River
- The position of the DCC gates
- Tidal exchange patterns
- Sacramento River discharge

When the water mass in the lower San Joaquin River in the Delta consists primarily of Sacramento River water, adult steelhead that would spawn in the Sacramento River may be attracted to the south Delta, and migration may be delayed or blocked until the adults find their way back to the Sacramento River (Hallock et al. 1970).

Sacramento River juvenile steelhead enter the Delta via the Sacramento River during migration to the ocean. As stated above, the most direct route through the Delta is the Sacramento River channel. However, some steelhead juveniles may be drawn along an alternate route through the DCC and Georgiana Slough, resulting in delayed migration and an increase in losses caused by diversions and predation. Studies have demonstrated that the survival levels of hatchery-reared fall-run Chinook salmon smolts that migrate directly down the Sacramento River are higher than those of smolts that migrate via channels that connect to the San Joaquin River (Brandes and McLain 2001). Migration of Chinook salmon juveniles through the DCC and Georgiana Slough exposes them to increased predation, higher temperatures, additional agricultural diversions, and complex channel configurations (potentially delaying or preventing seaward migration). Juvenile steelhead may be similarly affected.

When San Joaquin River inflow to the Delta is less than export levels at the CVP and SWP pumps in the south Delta, or when Old River near Mossdale is closed with a barrier, flows in Old and Middle rivers north of the facilities are reversed (i.e., flow toward the south). Reverse flows in Old and Middle rivers may adversely affect juvenile steelhead migrating through the Delta because they may stray from the Sacramento River to the San Joaquin River (Brandes and McLain 2001).

Migration pathways through the Delta for San Joaquin River steelhead are more directly affected by altered flow patterns. Reverse flows in Old and Middle rivers are believed to affect steelhead from the San Joaquin River by altering the environmental cues used by the migrating fish (Mesick 2001). As a result, the juveniles are more vulnerable to being entrained by the pumps, and migrations of both adults and juveniles are delayed. Reverse flows are likely to cause increased straying of migrating adults into the south Delta, where their progress may be impeded by barriers and irregular flow patterns (Mesick 2001).

Inflow from the San Joaquin River affects steelhead movement through the south Delta, which is generally considered to have relatively poor rearing habitat conditions (Nobriga et al. 2008; Monsen et al. 2007; Feyrer 2004). High inflows likely reduce straying of all life stages from the San Joaquin River channel into channels that lead toward the south Delta pumps. Higher inflows likely reduce the transit time of smolts through the Delta, thus reducing the amount of time they are exposed to predators, poor water quality, low food supply, and other mortality factors. Higher inflows may also provide stronger environmental cues for adult fish migrating upstream and smolts and other juveniles migrating downstream (Mesick 2001).

Inflow also affects water quality conditions in the south Delta. DO levels at the Stockton Deep Water Ship Channel (DWSC) are often low during late summer and early fall because of high water temperatures, algal biomass, and low river flow (Giovannini 2005; Lee and Jones-Lee 2003). Migrations of adult San Joaquin River salmon are often delayed by low DO levels near the Stockton DWSC (Giovannini 2005). Migrations of adult steelhead also may be affected, although steelhead adults migrate later in the year than fall-run Chinook salmon, when water temperature and DO conditions at the Stockton DWSC are generally much improved.

Sportfishing. Harvest of naturally spawned steelhead is prohibited within the Central Valley. Take is limited to one hatchery fish per day, and every hatchery fish is marked. Because hatchery fish are raised for harvest and are not particularly suitable to augmentation of wild stocks, their catch is not a detriment to the steelhead population as a whole. It is not clear what effect the incidental catch and release of wild steelhead has on the Central Valley steelhead population as a whole; however, some mortality likely occurs, which could be deleterious as numbers of wild fish continue to decline and a greater percentage of the fish is caught and released.

Ocean Habitat. Little is known about the use of ocean habitat by steelhead, although changes in ocean conditions are important for explaining trends among populations of steelhead along the Oregon coast (Kostow 1995). Evidence suggests that increased ocean temperatures associated with El Niño events may increase ocean survival as much as twofold (Ward and Slaney 1988). The magnitude of upwelling, which determines the amount of nutrients brought to the ocean surface and which is related to wind patterns, influences ocean productivity, with substantial effects on steelhead growth and survival (Barnhart 1991). Steelhead appear to prefer ocean temperatures of 48ºF to 53ºF and typically swim in the upper 30 feet to 40 feet of the ocean’s surface (Barnhart 1991).

5.1.2 Central Valley Spring-Run Chinook Salmon Evolutionarily Significant Unit

On September 16, 1999, NMFS listed the Central Valley spring-run Chinook salmon ESU as threatened under the Federal ESA. This ESU includes all naturally spawned populations of spring-run Chinook salmon in the Sacramento River and its tributaries (NMFS 1999). Critical habitat for this species was designated on February 16, 2000 (65 FR 7764). However, on April 30, 2002, a U.S. district court approved a NMFS consent decree withdrawing the critical habitat designation for this and 18 other ESUs of salmon and steelhead. On December 10, 2004, NMFS published a new proposal to designate critical habitat for seven ESUs of Chinook salmon and steelhead in California, including the Central Valley spring-run Chinook salmon (69 FR 237). The final designation for critical habitat was published on September 2, 2005, and became effective on January 2, 2006. The critical habitat includes roughly 1,272 miles of occupied stream habitat and 427 square miles of estuarine habitat, including the north Delta (the central and south Delta were excluded) and Suisun, San Pablo, and north San Francisco bays (NMFS 2004; 70 FR 170, September 2, 2005). The only area of critical habitat within the Action Area consists of the northern portions of the DCC, Georgiana Slough, and Threemile Slough, which connect the Sacramento and San Joaquin rivers.

NMFS published a draft recovery plan in 2009 for all listed Central Valley salmon, including Central Valley spring-run Chinook salmon (NMFS 2009b). This draft recovery plan identifies the factors that have led to the decline of the ESUs and DPSs, describes past conservation efforts, and provides a preliminary list of recommended recovery measures. Some of the measures listed are provided in the species account for Central Valley spring-run Chinook salmon.

Historic and Current Distribution

In the Central Valley, spring-run Chinook salmon historically migrated upstream to the headwaters of the larger tributaries to the Sacramento and San Joaquin rivers, where they held for several months in deep cold pools (Moyle 2002). Historic runs were reported in the McCloud, Pit, Little Sacramento, Feather, Yuba, and American rivers, and in the San Joaquin, Stanislaus, Tuolumne, and Merced rivers (Moyle 2002). Today, Central Valley spring-run Chinook salmon persist in only a few systems within the Sacramento River watershed.

Abundance Trends

Spring-run Chinook salmon in the Central Valley was once among the largest runs on the Pacific Coast (Yoshiyama et al. 1998). The Sacramento River drainage alone was estimated to support more than 100,000 spring-run Chinook salmon in many years between the late 1800s and 1940s (Moyle 2002). Before the construction of Friant Dam, nearly 50,000 adults were counted in the San Joaquin River alone (Fry 1961). Construction of other dams on the American, Mokelumne, Stanislaus, Tuolumne, Merced and San Joaquin rivers extirpated the spring-run Chinook salmon from these watersheds. Dam construction and irrigation diversions, which eliminated access to upstream spawning and holding areas eliminated spring-run Chinook salmon from the San Joaquin River Basin by the late 1940s (Skinner 1962) and greatly reduced spring-run numbers in the Sacramento River Basin. Because of extensive hatchery introductions, most spring-run Chinook salmon currently in the Sacramento and Feather rivers have hybridized with fall-run Chinook salmon and are heavily introgressed with fall-run Chinook salmon characteristics, particularly with regard to run timing (Yoshiyama et al. 1998). Stocks in Deer, Mill, and Butte creeks appear to have minimal to no hatchery influence.

The abundance of adult Central Valley spring-run Chinook salmon ESU has broadly fluctuated, ranging from 1,403 fish in 1993 to 25,890 in 1982 (NMFS 2009a). Sacramento River tributary populations in Mill, Deer, and Butte creeks are probably the best trend indicators for the spring-run ESU as a whole because these streams contain the primary independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991. Escapement numbers are dominated by Butte Creek returns, which have averaged more than 7,000 fish since 1995. During this same period, adult returns have averaged 778 fish on Mill Creek and 1,463 fish on Deer Creek. Although recent trends are positive, annual abundance estimates display a high level of fluctuation, and the overall number of spring-run remains far below estimates of historic abundance.

Life History

Some spring-run Chinook salmon are thought to exhibit a classic “stream-type” life history strategy, or trajectory (Moyle 2002). Stream-type Chinook salmon spend 1 year or more in freshwater before migrating downstream toward the ocean. As a result, stream-type juveniles are more dependent on freshwater streams. Stream-type (yearling) smolts are much larger than their ocean-type (subyearling) counterparts when entering salt water; therefore, they are able to move offshore relatively quickly, making extensive offshore oceanic migrations. This life-history pattern can separate spring-run Chinook salmon from other salmon runs.

Spring-run Chinook salmon historically migrated farther upstream than other Chinook salmon runs, taking advantage of habitats at higher elevations that were inaccessible during summer and fall (as a result of high temperatures and reduced stream flows in lower reaches) (Moyle 2002). This geographic separation also helped preserve their genetic integrity (Moyle 2002).

Only the adults and juveniles of Central Valley spring-run Chinook salmon occur in the Action Area; therefore, only these two life stages are discussed below.

Upstream Migration and Holding. Spring-run Chinook salmon begin their upstream migration in late January to early February (DFG 1998). They enter freshwater as sexually immature adult fish, and their holding period can last for several months before individuals are ready to spawn (Moyle 2002; DFG 1998). Spawning occurs during the fall. Like all other runs of Chinook salmon, adult spring-run Chinook salmon cease feeding after entering freshwater, so they need to conserve energy as they over-summer. Deep, cool, and oxygenated pools are important to salmon for energy conservation (Berman and Quinn 1991; DWR and Reclamation 2000).

Juvenile and Smolt Emigration. Juvenile spring-run Chinook salmon may rear in streams for 1 month to 15 months. Some authors (Yoshiyama et al. 1998; Moyle 2002) suggest that Central Valley spring-run Chinook salmon may be rearing for a shorter period than in past years as a response to altered flow regimes (caused by dams and diversions) and to their restriction to lower elevation sections of streams (again, because of dams). This has been shown in both Butte Creek and Feather River (Ward et al. 2002, McReynolds et al. 2006, 2007, Bilski and Kindopp 2009). Rearing occurs in natal streams, the mainstem of the Sacramento River, nonnatal streams, and the Delta. Juveniles that remain in their natal streams to rear tend to emigrate as yearlings, and those that rear in nonnatal streams leave as young-of-the-year (YOY).

Outmigrants may spend some time in the Sacramento River or the San Francisco Estuary, gaining additional size before smolting and migrating out to sea. Juveniles that migrate as yearlings move downstream with the onset of the stormy season, beginning in October of the year after spawning and continuing through March (DFG 1998).

Factors Affecting the Evolutionarily Significant Unit and Critical Habitat

The environmental factors most likely to affect the abundance and distribution of the Central Valley spring-run Chinook salmon ESU are discussed below.

Flow. Reservoir operations have altered the natural flow regime of Central Valley streams by changing the frequency, magnitude, and timing of flow. These changes may affect all life stages of spring-run Chinook salmon. Changes in the magnitude and timing of reservoir releases can influence the timing of migration by spring-run Chinook salmon. Relatively early attraction of spring-run Chinook salmon into tributaries can be triggered by occasional releases of cold water from reservoirs or the occurrence of naturally high flows early in the fall. Conversely, low flows and higher water temperatures can inhibit or delay migration to spawning areas.

Suitable flows are necessary year-round for juvenile rearing. As flow increases, the area preferred by juvenile Chinook salmon shifts from the center of the channel to submerged terrestrial vegetation on the edge of the channel and within the floodplain. Deeper inundation provides more overhead cover and protection from avian and terrestrial predators than shallow water (Everest and Chapman 1972). In broad low-gradient rivers, changes in flows can greatly increase or decrease the lateral area available to juvenile Chinook salmon, particularly in riffles and shallow glides.

The stream reaches that are presently accessible to spring-run Chinook salmon often lack the summer habitat conditions needed to sustain juvenile spring-run through their freshwater rearing period (70 FR 170, September 2, 2005). These conditions can be exacerbated by reservoir operations and water diversions that reduce summer flows, and can be particularly severe in drought years.

Water Temperature. Water temperature is a primary limiting factor for natural production of spring-run Chinook salmon on Central Valley streams (NMFS 1999). Appropriate water temperature regimes below many dams cannot be maintained at levels comparable to temperature regimes that were achieved naturally in the upper watersheds that previously provided habitat.

Altered Pathways for Adult and Juvenile Migration Through the Delta. The most direct route through the Delta for migrating adult and juvenile spring-run Chinook salmon is the Sacramento River channel. Factors affecting straying of spring-run adults and juveniles in the Delta and potential consequences are the same as those described later for winter-run Chinook salmon.

Diversions. Water diversions reduce the survival levels of emigrating juvenile salmonids by causing direct losses at unscreened or inadequately screened diversions and indirect losses associated with reduced streamflows. Fish screening and salvage efforts at major agricultural diversions have met with variable levels of success, and many smaller unscreened or inadequately screened diversions continue to operate. Fish losses at diversions can result from physical injury, impingement, entrainment, or predation. Delayed passage, increased stress, and increased vulnerability to predation also contribute to mortality caused by diversions. Diversion impacts on anadromous fish depend on diversion timing and magnitude, river discharge, life stage, and other factors.

The CVP and SWP export facilities in the south Delta adversely affect survival of anadromous fish in the Delta by resulting in direct losses caused by entrainment and in indirect effects related to changes in the magnitude and direction of flow in Delta channels. Increases in upstream storage and diversions over the last 20 years have significantly reduced inflow to the Delta. Reduced inflow, in combination with increased exports from the Delta, has caused an increase in adverse impacts on anadromous and resident species by reducing net flow through the Delta and Delta outflow. Unscreened Delta diversions have contributed to fish losses.

A portion of the juvenile spring-run Chinook salmon migrating down the Sacramento River may be drawn toward the CVP and SWP pumps. Although both pumping plants have louver-type fish screens that may be 90 percent effective for downstream-migrating spring-run Chinook salmon, high prescreening losses attributed to predation also occur, particularly at the CVP and SWP pumping plants.

5.1.3 Sacramento River Winter-Run Chinook Salmon Evolutionarily Significant Unit

The Sacramento River winter-run Chinook salmon is designated as an endangered species under the Federal ESA (59 FR 440, January 4, 1994). In 2004, NMFS evaluated whether Sacramento River winter-run Chinook salmon were still in danger of extinction and proposed downgrading the species' status to threatened; however, after review, NMFS determined that the protective measures in place were not enough to alter the level of extinction risk and determined that the status should remain designated as endangered (70 FR 170, September 2, 2005). Designated critical habitat for the Sacramento River winter-run Chinook salmon does not overlap the Action Area, but winter-run salmon are known to stray into the Action Area from the Delta portion of the Sacramento River.

NMFS published a draft recovery plan for all listed Chinook salmon in the Central Valley (NMFS 2009b). This draft recovery plan identifies the factors that led to the decline of the ESUs and DPSs, describes past conservation efforts, and provides a preliminary list of recommended recovery measures. Some of the measures listed are provided in the species account for Sacramento River winter-run Chinook salmon.

Historic and Current Distribution

Sacramento River winter-run Chinook salmon historically migrated all the way to the upper reaches of the Sacramento River and its tributaries, but barriers now restrict winter-run Chinook salmon to the river below Keswick Dam. Spawning occurs primarily in the

Sacramento River upstream from RBDD. Adult and juvenile winter-run Chinook salmon migrate through the Delta and Suisun, San Pablo, and San Francisco bays.

Abundance Trends

Historical populations of Sacramento River winter-run Chinook salmon approached an estimated 100,000 fish in the 1960s, but declined to fewer than 200 fish in the 1990s (NMFS 2009a). In recent years, population estimates of winter-run from carcass surveys included a high of 17,334 fish in 2006, followed by a precipitous decline to 2,488 in 2007 and the latest return estimate of 1,533 fish in 2010 (GrandTab Table http://www.calfish.org/LinkClick.aspx?fileticket=Kttf%2boZ2ras%3d&tabid=104&mid=524).

Life History

Sacramento River winter-run Chinook salmon have life history traits similar to those of steelhead. Because only adults and juveniles occur in the Action Area, only these two life stages are discussed below.

Upstream Migration. Adult winter-run Chinook salmon leave the ocean and migrate through the Delta into the Sacramento River from November through July. They migrate upstream past RBDD on the Sacramento River from mid-December through July, with most of the spawning population having passed RBDD by late June (69 FR 237, December 10, 2004). The migration is stopped at Keswick Dam since there is no fish ladder. Adult winter-run Chinook salmon typically hold in deeper pools for several months before spawning activity occurs from April through August, with peak in early June.

Juvenile and Smolt Emigration. Juvenile winter-run Chinook salmon rear in and emigrate through the Sacramento River and its tributaries from July through March (Hallock and Fisher 1985). Juveniles descending the Sacramento River above RBDD, from August through October and possibly November, are mostly presmolts. Juveniles have been observed in the Delta from October through December, especially when Sacramento River discharge is high because of fall and early-winter storms. Juvenile Chinook salmon move into downstream habitats in response to many factors, such as inherent behavior, habitat availability, flow, competition for space and food, and water temperature. The number of juveniles and the timing of their movement are highly variable. Storm events and the resulting high flows appear to trigger movement by substantial numbers of juveniles to downstream habitats. In general, the abundance of juvenile Chinook salmon in the Delta increases as flows increase (USFWS 1995a).

Factors Affecting the Evolutionarily Significant Unit and Critical Habitat

The environmental factors most likely to affect the abundance and distribution of the Sacramento River winter-run Chinook salmon ESU are discussed below.

Flow. Reservoir operations have altered the natural flow regime of Central Valley streams by changing the frequency, magnitude, and timing of flows. These changes may affect all winter-run Chinook salmon life stages. Changes in the magnitude and timing of reservoir releases can influence the timing of migration by winter-run Chinook salmon.

Suitable flows are necessary for juvenile rearing. A high flow increases the rearing area available to juvenile Chinook salmon because they commonly use submerged terrestrial vegetation on the channel edge and the floodplain. Deeper inundation provides more overhead cover and protection from avian and terrestrial predators than shallow water (Everest and Chapman 1972). In broad low-gradient rivers, changes in flows can greatly increase or decrease the lateral area available to juvenile Chinook salmon, particularly in riffles and shallow glides.

Temperature. Deleterious water temperatures during spawning, incubation, and early rearing periods restrict the winter-run Chinook salmon to the Sacramento River primarily upstream from RBDD. Survival of juveniles begins to decline substantially at temperatures above 65°F. During the period when juvenile winter-run Chinook salmon migrate through the Delta, water temperature is generally below 60°F. Therefore, winter-run salmon juveniles likely do not experience a high magnitude of loss as a result of Delta water temperatures (USFWS 1995a).

Barriers to Fish Passage. Sacramento River winter-run Chinook salmon historically spawned in the upper Sacramento River and its major tributaries, the McCloud and Pit rivers. The construction of Shasta Dam blocked access to historical habitat and restricted spawning to the mainstem Sacramento River immediately downstream.

Operation of RBDD is considered one of the primary causes of the reduction in abundance of winter-run Chinook salmon. RBDD is a barrier to upstream-migrating adults, preventing upstream passage for up to 40 percent of winter-run Chinook salmon and delaying the remaining fish for several days (USFWS 1988; Hallock 1983). Salmon that are delayed may suffer reduced fecundity. Winter-run that do not migrate upstream past RBDD do not spawn successfully during most years because of elevated water temperatures (Hallock 1983).

Since 1986, the RBDD gates have been raised during winter and early spring as part of a protection program for winter-run Chinook salmon, thereby reducing delays and blockage of adults. Improved passage through RBDD after 1986 has not reversed the decline in abundance, however. Abundance increased in 2005 and 2006, but this increase may have been the result of ocean conditions or other factors. In 2008, a Record of Decision was published for the Red Bluff Diversion Dam Fish Passage Improvement Program will result in a fish screen along the river that acts as a positive barrier to keep fish in the river while allowing water to be diverted into the canal system (Reclamation 2008b). Construction is expected to be completed at the end of 2012.

Altered Pathways for Adult and Juvenile Migration Through the Delta. The most direct route through the Delta for migrating adult winter-run Chinook salmon is the Sacramento River channel. Sacramento River water may be transported into the lower San Joaquin River via the DCC, Georgiana Slough, and Threemile Slough, and at the confluence of the Sacramento and San Joaquin rivers. The following factors affect the proportion of Sacramento River water drawn into the lower San Joaquin River:

- Diversions from and inflow to the Delta east of the Sacramento River
- The position of the DCC gates
- Tidal exchange patterns
- Sacramento River discharge

When most of the water mass in the lower San Joaquin River originates from the Sacramento River, adult winter-run Chinook salmon may be attracted to the south Delta, delaying their migration (Hallock et al. 1970).

The effect of delay on spawning conditions depends on the duration of the delay and the condition of females during the spawning migration. Winter-run Chinook salmon females usually pass through the Delta in green condition (i.e., before eggs mature); the eggs ripen months after the salmon arrive in their natal spawning area.

Juvenile winter-run Chinook salmon enter the Delta via the Sacramento River during migration to the ocean. As stated above, the most direct route through the Delta is the Sacramento River channel. However, some winter-run Chinook salmon juveniles are drawn along an alternate route through the DCC and Georgiana Slough, resulting in delayed migration and an increase in losses caused by diversions and predation. Studies have demonstrated that survival of hatchery-reared fall-run Chinook salmon smolts that migrate directly down the Sacramento River is higher than that of smolts that migrate via the channels connecting to the San Joaquin River (Brandes and McLain 2001). Migration of Chinook salmon juveniles through the DCC and Georgiana Slough exposes them to increased predation, higher temperatures, additional agricultural diversions, and complex channel configurations that may delay or prevent seaward migration. Juvenile winter-run Chinook salmon may be similarly affected.

When San Joaquin River inflow to the Delta is less than export levels at the CVP and SWP export facilities in the south Delta, or when Old River near Mossdale is closed with a barrier, flows in Old and Middle rivers north of the facilities are reversed. Reverse flows in Old and Middle rivers may adversely affect juvenile salmon that are migrating through the Delta, including Sacramento River winter-run Chinook salmon that have entered the central Delta (USFWS 1992, 1995a).

In December 1999, under overall low-flow conditions and high export pumping rates, Delta salinity increased when the DCC gates were closed to protect emigrating juvenile Sacramento River winter-run Chinook salmon. This experience and other, similar experiences in recent years have indicated the need for tools to facilitate operating the DCC gates to better balance fisheries, water quality, and water supply objectives. This understanding led the CALFED Bay-Delta Program to consider how to preserve both the benefits to fish of closing the DCC gates and the benefits to water quality of diverting Sacramento River water into the interior Delta, particularly during low-flow periods. As a result, proposals are being considered to screen the DCC gates to divert a smaller amount of water than the gates' present capacity. The understanding also led to provisions in the 1995 water quality control plan and recent biological opinions for listed Chinook salmon that require closure of the DCC during extended periods of time. Closures were designed to reduce the fraction of salmon diverted to the interior Delta, thus improving overall salmon survival (69 FR 237, December 10, 2004).

The CVP and SWP export facilities in the south Delta adversely affect survival of anadromous fish in the Delta by resulting in direct losses caused by entrainment, and in indirect effects related to changes in the magnitude and direction of flow in Delta channels. Increases in upstream storage and diversions over the last 20 years have substantially reduced inflow to the Delta. Reduced inflow, in combination with increased exports from the Delta, has caused an increase in adverse impacts on anadromous and resident fish species by reducing net flow through the Delta and Delta outflow.

Diversions. Water diversions reduce the survival levels of emigrating juvenile salmonids by causing direct losses at unscreened or inadequately screened diversions and indirect losses associated with reduced streamflows. Fish screening and salvage efforts at major agricultural diversions have met with variable levels of success, and many smaller unscreened or inadequately screened diversions continue to operate. Fish losses at diversions can result from physical injury, impingement, entrainment, or predation. Delayed passage, increased stress, and increased vulnerability to predation also contribute to mortality caused by diversions. Impacts of diversions on anadromous fish depend on diversion timing and magnitude, river discharge, life stage, and other factors.

Juvenile winter-run Chinook salmon migrate through the Delta from January through April. Agricultural diversion levels are low during most of this period, and are highest during late spring and summer (DWR 1990). Diversion levels at the CVP and SWP pumps are high during March and April, however, and entrainment losses of winter-run Chinook salmon juveniles may be substantial (DWR 1990). Storm events and increased Sacramento River discharge may move many winter-run juveniles to the Delta between October and January. Increased Delta exports during such times likely increase direct and indirect entrainment losses.

Harvest. Although ocean harvest of Sacramento River winter-run Chinook salmon is not considered a key factor leading to the decline of the population, NMFS does consider ocean harvest to be an important source of mortality to the population (69 FR 237, December 10, 2004). The harvest rate of winter-run Chinook salmon is lower than the harvest rate calculated for other runs, primarily because winter-run adults migrate from the ocean from December through May, before the main fishing season opens (NMFS 1996). Sacramento River winter-run Chinook salmon adults migrate when they are 2 years to 3 years old. Fish that are 2 years old do not reach legal commercial size in the ocean, and most 3-year-old fish reach legal size late in the commercial season. Legal size limits for sportfishing allow the take of 2-year-old fish, and about 70 percent of the ocean catch of Sacramento River winter-run Chinook salmon may be attributable to sportfishing (NMFS 1996).

Ocean-fishing regulations have been implemented to further restrict the sportfishing season and close some areas to fishing, but the effects of these changes on catch of Sacramento River winter-run Chinook salmon are uncertain. Fishing is not likely a a major factor in the decline of the winter-run Chinook salmon population, however fishing mortality could delay recovery of the run if other limiting factors were ameliorated.

5.1.4 Central Valley Fall-/Late Fall-Run Chinook Salmon Evolutionarily Significant Unit

Central Valley fall-run/ late fall-run Chinook salmon are considered by NMFS to be the same ESU (64 FR 50394–50415, September 16, 1999). Fall-run Chinook salmon is currently the most abundant and widespread salmon run in California (Mills et al. 1997). NMFS determined that listing this ESU as threatened was not warranted (64 FR 50394–50415, September 16, 1999), but subsequently classified it as a species of concern because of specific risk factors (69 FR 19975, April 15, 2004).

Historic and Current Distribution

In the San Joaquin River Basin, fall-run Chinook salmon historically spawned in the mainstem San Joaquin River upstream from the Merced River confluence and in the mainstem channels of the major tributaries. Dam construction and water diversion dewatered much of the mainstem San Joaquin River, limiting fall-run Chinook salmon to the three major tributaries, where they currently spawn and rear downstream from mainstem dams. Late fall-run Chinook salmon do not occur in the San Joaquin River system.

Abundance Trends

Estimates of fall-run Chinook salmon abundance are available from 1940, but systematic counts of salmon in the San Joaquin River Basin began in 1953, long after construction of large dams on the basin’s major rivers. Comparable estimates of population size before 1940 are not available. Since population estimates began, the number of fall-run Chinook salmon returning to the San Joaquin Basin annually has fluctuated widely.

In the last 25 years, escapement in the Merced River has fluctuated between 82 spawners in 1990 to 16,000 spawners in 1985. Most recent estimates in the Merced River have all been under 1,000 spawning fish. Escapement in the Tuolumne River fluctuates between 40,000 to fewer than 100 fish, most recently dropping to an estimated 124 spawning fish in 2009, and slightly increasing in 2010 to an estimated 540 spawners (GrandTab Table http://www.calfish.org/LinkClick.aspx?fileticket=Kttf%2boZ2ras%3d&tabid=104&mid=524). Similarly, the Stanislaus River population estimates ranged between over 13,000 spawning fish (1985) to a low of 168 fish in 1996 (GrandTab Table http://www.calfish.org/LinkClick.aspx?fileticket=Kttf%2boZ2ras%3d&tabid=104&mid=524). Hatchery-produced fish have been estimated to account for about 30 percent to 60 percent of the fall-run Chinook run in the San Joaquin River Basin since 1991 (Yoshiyama et al. 1998).

Except for timing, the life-history characteristics and habitat requirements for fall-/late fall-run Chinook salmon are similar to those for both spring- and winter-run Chinook salmon. The differences are described below.

Life History

Migration by fall-run adults to spawning habitat, and thus through the Delta, is typically initiated around June and continues through December, but peaks in October and November. Spawning takes place primarily between October and December. Late fall-run Chinook salmon adults migrate upstream in the Sacramento River system between late October and April, spawning from January through April.

Fall-run salmon fry disperse downstream from early January through mid-March, whereas the smolts migrate primarily between late March and mid-June in the Stanislaus River (SJRRP 2010). Late fall-run, however, begin outmigration after rearing in freshwater for 7 months to 13 months.

Fall-run smolts enter the San Francisco estuary primarily in May and June (MacFarlane and Norton 2002), where they spend days to months completing the smoltification process in preparation for ocean entry and feeding (Independent Scientific Group 1996). Within the estuarine habitat, movements by juvenile Chinook salmon are dictated by the tidal cycles, following the rising tide into shallow-water habitats from the deeper main channels, then returning to the main channels when the tide recedes (Levy and Northcote 1981; Healey 1991).

Juvenile Chinook salmon spent an average of about 40 days migrating through the Delta to the mouth of San Francisco Bay in spring 1997, but grew little in length or weight until they reached the Gulf of the Farallon Islands (MacFarlane and Norton 2002).

Based on the mainly ocean-type life history observed (i.e., fall-run Chinook salmon), MacFarlane and Norton (2002) concluded that unlike other salmonid populations in the Pacific Northwest, Central Valley Chinook salmon show relatively little estuarine dependence and may benefit from expedited ocean entry. The absence of extensive marsh habitats outside of Suisun and San Pablo bays and the introduction of exotic zooplankton species may limit important food resources in the San Francisco estuary that are present in other Pacific Northwest estuaries (MacFarlane and Norton 2002).

When fall-run Chinook salmon produced from the Sacramento and San Joaquin watersheds enter the ocean, they appear to head north and rear off the coast of northern California and southern Oregon (Cramer 1987). Fall-run Chinook salmon typically rear in coastal waters early in their ocean life. Ocean conditions are likely an important cause of density-independent mortality and interannual fluctuations in escapement sizes. Central Valley Chinook salmon typically spend 2 years to 4 years at sea (Mesick and Marston 2007). Most mortality experienced by salmonids during the marine phase occurs soon after ocean entry (Pearcy 1992; Mantua et al. 1997).

Factors Affecting the Evolutionarily Significant Unit

Factors affecting fall-run adults and juveniles Chinook salmon are in general very similar to those factors that have been described above for other runs of Chinook salmon.

Low flows limit habitat area and adversely affect water quality by elevating water temperatures and depressing dissolved oxygen. High water temperatures and fluctuations in water temperature result from a combination of factors, including warm agricultural runoff, low flow releases, seasonally high air temperatures during summer months, and removal of large woody riparian forests that provided shade and IWM. These conditions stress incubating eggs and rearing juveniles. Furthermore, elevated water temperature increases the threat of heightened predation by nonnative fish species adapted to higher temperature.

5.1.5 Southern Distinct Population Segment of North American Green Sturgeon

North American green sturgeon have been separated into two DPSs: the northern DPS (populations north of and including the Eel River) and the southern DPS (coastal and Central Valley populations south of the Eel River). On April 15, 2004, NMFS announced that the listing status for the northern and southern DPSs of green sturgeon would change from a candidate species to a species of concern (69 FR 117). However, litigation challenged the NMFS determination that green sturgeon did not warrant listing as an endangered or threatened species under the ESA. The legal challenge asserted that the agency was arbitrary and capricious in failing to examine whether habitat loss constituted a significant portion of the species' range (70 FR 65, April 6, 2005). The court partially agreed with the plaintiff's motion, and remanded the determination to NMFS for further analysis and a decision on whether the green sturgeon northern and southern DPSs are endangered or threatened in a significant portion of their range. After the review, the southern DPS was listed as threatened under the Federal ESA (71 FR 67, April 7, 2006). Critical habitat was later designated for the southern DPS of the North American green sturgeon (74 FR 52300-52351, October 9, 2009).

NMFS has not prepared a recovery plan for the southern DPS of the North American green sturgeon. However, the USFWS *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* (USFWS 1996) includes a discussion of factors responsible for the decline of green sturgeon and a description of restoration objectives and recovery criteria.

Historic and Current Distribution

Green sturgeon are found in the lower reaches of large rivers from British Columbia south to the Sacramento River. The southernmost spawning population is in the Sacramento River. Spawning populations existed historically in the Eel and Klamath-Trinity River systems. The Klamath River still maintains a spawning population, but the Eel and Trinity rivers do not. In the Central Valley, spawning habitat may have extended to the Butte Creek watershed. Currently, spawning occurs in the mainstem Sacramento River and some spawning may occasionally take place in the Feather River (Beamesderfer and Webb 2002). The historical presence of green sturgeon spawning populations in San Joaquin River is unclear. There are no records, historic or current indicating green sturgeon use of this drainage (NMFS 2005).

Juvenile fish have been collected in the Sacramento River near Hamilton City, and in the Delta and San Francisco Bay. Adults and juveniles have been observed near RBDD in late winter and early spring. Individuals tagged by DFG in the Delta have been recaptured off Santa Cruz, California; in Winchester Bay on the southern Oregon coast; at the mouth of the Columbia River; and in Grays Harbor, Washington (Moyle 2002).

Abundance Trends

Limited information about population abundance for the southern DPS of North American green sturgeon comes from incidental captures by a DFG sturgeon tagging program to monitor white sturgeon (NMFS 2009a). By comparing ratios of white-sturgeon captures to green-sturgeon captures, DFG has estimated the abundance of adult and subadult green sturgeon. Estimated abundance between 1954 and 2001 ranged from 175 fish to more than 8,000 fish, with an average of 1,509 fish per year. However, because of biases and errors, DFG does not consider these estimates reliable.

The only existing information about changes in abundance of the southern DPS of green sturgeon relates to changes in abundance of green sturgeon salvaged at the south Delta export facilities between 1968 and 2006. Before 1986, the average number of southern DPS of green sturgeon salvaged per year at the two export facilities combined was 1,621; from 1986 on, the average per year was fewer than 100 (70 FR 17386–17401, April 5, 2005). In light of the decreased exports, it is clear that the abundance of green sturgeon is declining. Recent estimates of spawning populations above RBDD using sibling-based genetics indicate 32 spawners in 2002, 64 in 2003, 44 in 2004, 92 in 2005, and 124 in 2006, with an average of 71 (NMFS 2009a).

Life History

Green sturgeon are anadromous, migrating from the ocean between March and July to spawn when temperatures in the rivers are between 45°F and 57°F. Females produce 60,000 eggs to 140,000 eggs, which are broadcast in swift water, then fertilized externally. Eggs hatch in about 8 days at 55°F. Juvenile (1- to 3-year-old) green sturgeon generally migrate downstream in spring or fall. During this time they remain close to estuaries, subsequently migrating long distances as they grow. Males tend to grow more slowly and mature more rapidly than females; consequently they spend only 3 years to 9 years at sea before returning, whereas females spend 3 years to 13 years at sea before returning. Mature fish are typically 15 years to 20 years old. Juveniles are known to consume small fish and amphipods; adults eat fish, shrimp, mollusks, and other large invertebrates.

Factors Affecting the Distinct Population Segment and Critical Habitat

The environmental factors most likely to affect the abundance and distribution of the southern DPS of North American green sturgeon are discussed below.

Flow. Low flow rates likely reduce survival and production of the southern DPS of the North American green sturgeon by hindering the dispersal of larvae to areas of greater food availability and suitable habitat, delaying the transportation of larvae downstream from water diversions in the Delta, and decreasing nutrient supply to their nurseries (DFG 1992a).

Water Temperatures. High water temperatures, which were once a problem for sturgeon in the Sacramento River, were remedied when a temperature control device was installed at Shasta Dam in 1997. Although Shasta Lake has limited storage capacity and cold-water reserves could be depleted in long droughts, water temperatures at RBDD have not been higher than 61°F since 1995. Optimal water temperatures for development, growth, and survival of green sturgeon eggs and larvae are between 59°F and 66°F (Mayfield and Cech 2004). Before the temperature control device was installed, green sturgeon reproduction may have been adversely affected by temperature, potentially affecting the overall population size and age structure.

Water Quality. Contamination of the Sacramento River increased substantially in the mid-1970s when application of rice pesticides increased (USFWS 1995a). White sturgeon may also bioaccumulate polychlorinated biphenyls (PCB) and selenium (White et al. 1989). Although green sturgeon spend more time in the marine environment than white sturgeon and may have less exposure, some risk still exists from contaminants. In addition, sediments in the water during the spawning period may reduce the adhesive properties of green sturgeon eggs, which in turn may result in reduced spawning success.

Barriers to Fish Passage. Restriction of spawning to a limited area of the Sacramento River is considered the primary factor explaining the decline of the southern DPS of green sturgeon. Dams are impassible barriers that block access by green sturgeon to what were likely historic spawning grounds upstream (USFWS 1995a; 69 FR 117, April 15, 2004). Potential barriers to migration by adult green sturgeon consist of Keswick and Oroville dams, RBDD, the Sacramento DWSC locks, Fremont Weir, the Sutter Bypass, the DCC gates on the Sacramento River, and Shanghai Bench and the Sunset Pumps on the Feather River (70 FR 65, April 6, 2005).

Water Diversions and Exports. The threats to green sturgeon posed by screened and unscreened agricultural water diversions and municipal and industrial diversions in the Sacramento River and Delta are largely unknown because juvenile sturgeon are often not identified, and because current NMFS and DFG screening criteria do not address sturgeon. The high density of water diversion structures along rearing and migration routes of green sturgeon presents a potential threat; therefore, NMFS has recommended further studies (70 FR 65, April 6, 2005).

Introductions of Nonnative Species. Several nonnative species that have been introduced into the San Francisco Estuary outcompete the native species, causing the food sources available to green sturgeon to be replaced. For example, the Asian clam (*Potamocorbula amurensis*), introduced in 1988, has become the most common food of white sturgeon and was found in the only green sturgeon examined (DFG 2002). This clam is known to bioaccumulate selenium, a toxic metal that could affect the physiology of the green sturgeon (DFG 2002). Green sturgeon juveniles may also experience predation by introduced species, including striped bass.

Sportfishing. Green sturgeon are highly susceptible to mortality from sportfishing. When harvest rates are high, population recovery is slow because of the green sturgeon's slow growth rate, long life span, and age at first spawn. Protective measures have been implemented restricting harvest to sturgeon 46 inches to 72 inches long. Most sturgeon sportfishing in the Central Valley is for white sturgeon, but green sturgeon are caught incidentally.

5.1.6 Delta Smelt

Delta smelt are endemic to the Delta (Moyle 2002). USFWS listed delta smelt as threatened (58 FR 12854–12864, March 5, 1993), and designated critical habitat in December 1994 (59 FR 65256–65279, December 19, 1994). Critical habitat for delta smelt includes all of Suisun Bay, including the contiguous Grizzly and Honker bays; Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the Delta (59 FR 65256–65279, December 19, 1994).

In response to a petition received on March 9, 2006, from the Center for Biological Diversity, the Bay Institute, and the Natural Resources Defense Council, USFWS is currently considering information to determine whether the listing status should be upgraded from threatened to endangered (73 FR 74674–74675, December 9, 2008).

USFWS issued the *Recovery Plan for the Sacramento–San Joaquin Delta Native Fishes* in 1996 (USFWS 1996). The recovery plan calls for the Delta to be managed to improve habitat for native fishes in general, with an emphasis on delta smelt. Recovery of delta smelt consists of restoring smelt populations and habitat to enable delisting of the species. Delta smelt will be considered restored when the species' population abundance and distribution return to levels that existed between 1967 and 1981, as determined by criteria related to DFG's fall midwater trawl surveys. A 5-year evaluation period that includes very high and low Delta outflow conditions, comparable to those that preceded the species' listing, is used to determine the delta smelt's recovery status. Delta smelt will be considered for delisting when the species meets designated recovery criteria under the conditions of the 5-year evaluation, and when measures are in place to ensure the species' continued existence.

In 2004, USFWS completed the 5-year status review for delta smelt, concluding that the threats described in the original listing remained: destruction and modification of habitat resulting from extreme outflow conditions, CVP and SWP operations, and other water diversions. The review concluded that numbers of delta smelt were falling below the effective population size, and that therefore, the Federal listing of delta smelt as a threatened species continued to be warranted (USFWS 2004). Another 5-year review was initiated in 2009, and is currently underway.

Historic and Current Distribution

Delta smelt spend their entire lives in the Delta and Suisun Bay, and when Delta outflow is high, in the eastern portion of San Pablo Bay. Their abundance has declined greatly in recent years, but their overall distribution is essentially unchanged (USFWS 2008). Under normal outflow conditions, delta smelt aggregate most of the year in the western Delta and eastern Suisun Bay to forage, and adults migrate upstream in winter to spawn in freshwater within the upper Delta. During periods of high Delta outflow, they also spawn in Suisun Marsh channels and the Napa River (Bennett 2005). Spawning adults and larvae have been found throughout the Delta, but they are typically most abundant in the northern, western, and central Delta (Bennett 2005).

Abundance Trends

Delta smelt have always varied in abundance from year to year, but they were once one of the most common fish species in the Delta (USFWS 2008). Numerous factors have likely contributed to a decline in the abundance and range of delta smelt:

- Hydraulic mining in the upper watershed of several tributaries of the Sacramento and San Joaquin rivers, which altered sediment and flow patterns in the Delta.
- Levee construction in the Delta, which resulted in the loss of seasonally flooded habitats and further changed flow patterns.
- Introduction of exotic fish and invertebrate species, which compete with delta smelt for zooplankton, compete with the preferred prey of delta smelt for algae, or prey on the smelt.
- Reduced water quality, which affects both delta smelt and its prey.
- Water exports, which entrain smelt, radically change natural flow patterns in the Delta, and adversely affect the location of the low-salinity zone (LSZ).

The LSZ is a shifting area of low salinity that provides habitat for a suite of specialized organisms that survive in its unique confluence of freshwater and marine influences (Kimmerer 2004). The LSZ centers around 2 practical salinity units and ranges from about 6 practical salinity units down to 0.5 practical salinity unit. According to seven abundance indices designed by the Interagency Ecological Program for the San Francisco Estuary to record trends in abundance, the population of delta smelt has been consistently low for several years, relative to historical levels of abundance (USFWS 2008). For example, the summer tow-net survey has recorded relatively low levels of abundance since 1983, with only a few exceptions. In addition, results from the fall midwater trawl surveys indicate that delta smelt abundance has declined irregularly over the past 20 years. In recent years, the species’ abundance has declined even further, including record-low delta smelt abundance indices since 2002. The recent decline has occurred despite relatively high Delta inflow conditions during several years. In addition to declines in delta smelt and other fish species, the abundance of many zooplankton species that are important prey for numerous life stages of delta smelt also has declined.

Life History

As mentioned previously, delta smelt complete their life cycle entirely within the Delta and the seaward estuary. The species is occasionally found in the Sacramento and San Joaquin rivers upstream from the Delta. Most delta smelt live for only a year, but a small proportion of adults survive to spawn in a second year (Moyle 2002). They are pelagic, inhabiting open water away from the shoreline and bottom. Delta smelt tolerate a relatively broad range of salinities, aggregating in brackish water (the LSZ) during most of the year, and migrating into freshwater to spawn.

Adult delta smelt begin their spawning migrations, which may last for several months, during December or January. The spawning location varies from year to year, depending in part on Delta inflows (Bennett 2005). In recent years, concentrations of larvae have been found in Cache Slough and the Sacramento DWSC in the north Delta, although spawning also occurs in the lower Sacramento and San Joaquin rivers (USFWS 2008). In years of high Delta outflow, delta smelt may spawn in Suisun Marsh or the Napa River, a tributary of San Pablo Bay. The upstream migration seems to be triggered or cued by abrupt changes in flow and turbidity associated with the first flush of winter rain, but can also occur after very high flood flows have receded (USFWS 2008). Spawning occurs from February through June, with peak spawning in April and May (Bennett 2005). Spawning generally begins when water temperatures approach 54ºF and ceases when they are around 64ºF (USFWS 2008). Spawning has never been observed in the wild, but sand and gravel are believed to be preferred spawning substrates (Bennett 2005). Eggs sink to the bottom and attach to the substrate.

Egg incubation takes 7 days to 18 days, depending on water temperature, and larvae begin feeding 4 days to 6 days later (Bennett 2005). Larval smelt feed on small zooplankton. Larvae and juveniles gradually move downstream toward rearing habitat in the LSZ (indexed as X2, defined as the distance from the Golden Gate Bridge where water salinity is 2 parts per thousand (ppt)), where they reside until the following winter (Moyle 2002). The juveniles typically begin to appear in the population in May; they may remain in upstream portions of the Delta for about a month, particularly during years with low Delta inflow. The location of the delta smelt population follows changes in the location of the LSZ, which depends primarily on Delta outflow.

Factors Affecting the Species and Critical Habitat

Flow. Delta flows have major effects on delta smelt. Except under flood flow conditions, the largest flows in the Delta are tidal flows, which far exceed other flows in most Delta channels, but nontidal flows determine the net direction of water movement and therefore strongly affect the distribution of delta smelt.

Spring storage of runoff in upstream reservoirs, summer reservoir releases for agriculture, and large-volume exports from the CVP and SWP facilities in the south Delta have been especially instrumental in altering the natural spatial and temporal flow patterns of the Delta. The CVP and SWP pumps have a strong effect on distributions of delta smelt in the south Delta because exports often cause water to flow upstream (i.e., reverse flow). Reverse flows in the south Delta make delta smelt more vulnerable to entrainment at the pumps and create conditions that delay migrations. Reverse flows are believed to affect fish movements by directly transporting weak swimmers such as larval fish (Monsen et al. 2007; Kimmerer 2004) and providing inappropriate environmental cues to migrating adult fish.

Elevated Delta inflows counteract the export pumps' negative effects on flow patterns, providing appropriate environmental cues to upstream-migrating adults and successfully transporting newly hatched larvae to the LSZ. Extreme flood flows may be catastrophic, however, because delta smelt and their food resources can be flushed out of the ecosystem entirely.

Delta outflow largely determines the location of X2 and the LSZ, an area that historically had high prey densities and other favorable habitat conditions for rearing delta smelt (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat conditions when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers. When Delta outflow is low, X2 is located in the relatively narrow channels of these rivers, whereas at higher outflows it moves downstream into more open waters (Kimmerer 2004).

Delta smelt may be vulnerable to reverse flows and entrainment in south Delta pumps at any time during their lives; however, they are especially vulnerable as mature adults during spawning migrations, especially in the central or south Delta, and as larvae before their downstream migration. However, in years of low Delta outflow, when the LSZ is located upstream from the confluence of the Sacramento and San Joaquin rivers, all life stages of delta smelt may be subject to the influence of reverse flow and movement into the south Delta.

Temperature. The south Delta often has poor water temperatures for delta smelt, especially during late summer and early fall (Nobriga et al. 2008; Feyrer 2004; Kimmerer 2004). Water temperature is high in this area relative to other parts of the Delta, presumably because the south Delta receives inflow from the San Joaquin River directly, which is likely to be somewhat warmer than the Sacramento River, and because of the longer residence time for water in the south Delta.

Entrainment. The export facilities at the Jones Pumping Plant and the Banks Pumping Plant, operated by the CVP and SWP, respectively, are the largest diversions in the Delta. These facilities entrain millions of fish each year, including adult, juvenile, and larval delta smelt (Reclamation 2008a). The facilities have fish screens used to salvage fish greater than a certain size (believed to be about 20 millimeters), but many of the salvaged fish are assumed not to survive the return to the Delta (Kimmerer 2004) because they are delicate. Losses at the export facilities have been shown to contribute to recent declines of delta smelt (Kimmerer 2008). Diversions reduce fitness not only by resulting in mortality from entrainment, but also by changing flow patterns that determine how delta smelt and important habitat variables are distributed in the Delta. Power plants, municipal diversions, and hundreds of agricultural diversions in the Delta are also responsible for entraining delta smelt.

Contaminants. Toxic chemicals such as mercury, selenium, and pesticides are a concern for Delta fishes, although their effect on delta smelt is uncertain (Bennett 2005). Recently, high levels of ammonium discharged from the Sacramento Regional Wastewater Treatment Plant have been suggested as a possible cause of reduced productivity of the food web supporting delta smelt (Dugdale 2008).

Predation. Delta smelt are vulnerable to predation by striped bass, largemouth bass, and other piscivorous fish species. The larvae are vulnerable to predation by many other fishes, including inland silversides and juvenile Chinook salmon and steelhead (Bennett 2005). Predation rates for delta smelt are likely higher in the south Delta than in other parts of the Delta for several reasons:

- Turbidity is generally lower in the south Delta; therefore, fish are more visible to their predators (Nobriga et al. 2008; Feyrer et al. 2007).
- Many of the structures and facilities in the south Delta, particularly Clifton Court Forebay and the fish louver screens at the Jones and Banks pumping plants, concentrate or disorient prey fish and provide ambush sites for predaceous fish (Reclamation 2008a).
- Recent invasions by the submerged plant Brazilian waterweed (*Egeria densa*) provide favorable habitat conditions for black bass species, which prey heavily on young fish life stages (Nobriga and Feyrer 2007; Nobriga et al. 2005).

Food Resources

Delta smelt juveniles and adults eat primarily copepods, but they also prey on cladocerans, mysids, amphipods, and larval fish (Bennett 2005). During the 1970s and 1980s, delta smelt diets were dominated by zooplankton (*Eurytemora affinis*, *Neomysis mercedis*, and *Bosmina longirostus*), but none of these are currently important prey (USFWS 2008). When delta smelt diets were examined again between 1988 and 1996, they were consistently dominated by the copepod *Pseudodiaptomus forbesi*, which was introduced and became abundant after the overbite clam invaded Suisun Marsh. More recent introductions of copepod species have adversely affected delta smelt feeding (USFWS 2008).

Introduction of the overbite clam to the Delta in 1986 was followed by a dramatic decline in algae production. The clam does not encroach into freshwater, but its grazing effect does, presumably because of the tides. The clam has reduced the standing crop of algae to fractions of historic levels, which has contributed to declines in the abundance of many zooplankton and fish species, but the contribution to delta smelt's decline is uncertain (Kimmerer 2002; Bennett 2005).

Pseudodiaptomus was historically most abundant in the LSZ; however, the abundance of *Pseudodiaptomus* and other important prey species of delta smelt in the LSZ has declined in recent years, presumably because the overbite clam is now abundant in Suisun Bay and the lower Delta. As indicated previously, the LSZ is typically located near the juncture of the Delta and Suisun Bay. During this period, *Pseudodiaptomus* abundance has increased in the south Delta, where it is now more abundant than in the LSZ. Because of the elevated risks of entrainment and predation, the south Delta is not good foraging habitat for delta smelt. However, *Pseudodiaptomus* produced in the south Delta may be transported to other areas where it would be a potentially important food resource for delta smelt.

5.2 Essential Fish Habitat

EFH is defined as the aquatic habitat (water and substrate) necessary for fish to spawn, breed, feed, or grow to maturity (50 Code of Federal Regulations Part 227, March 19, 1988) that will allow a level of production needed to support a long-term, sustainable commercial fishery and contribute to a healthy ecosystem. The following important components of EFH must be adequate for spawning, rearing, and migration:

- Substrate composition
- Water quality
- Water quantity, depth, and velocity
- Channel gradient and stability
- Food
- Cover and habitat complexity
- Space
- Access and passage
- Habitat connectivity

The Pacific Fishery Management Council's (PFMC) *Pacific Coast Groundfish Fishery Management Plan* has designated EFH for 83 species of groundfish (PFMC 2008). Taken together, these species include fish found in all waters from the high-water line, and the upriver extent of saltwater intrusion in river mouths along the coast from Washington to California.

All Chinook salmon ESUs are combined and referred to as Pacific salmon. PFMC manages Pacific salmon under the Pacific Salmon Fishery Management Plan. The Council included Sacramento and San Joaquin rivers and their tributaries as EFH for Central Valley Chinook stocks. Species descriptions for Central Valley spring-run Chinook salmon, Sacramento River winter-run Chinook salmon and Central Valley fall-/late fall-run Chinook salmon (combined is the Pacific salmon) are provided above, and descriptions of starry flounder is provided below.

5.2.1 Starry Flounder

The starry flounder (*Platichthys stellatus*) is managed by the *Pacific Coast Groundfish Fishery Management Plan*. "Composite habitats" most important for the starry flounder are estuarine habitats (for all life stages), nonrocky shelf habitats (for juveniles and adults), and shallow coastal habitats (for eggs and larvae), as defined by the fishery management plan (Reclamation 2008a). The starry flounder "Composite Estuarine EFH" overlaps the Action Area for the Proposed Action. Therefore, the species is subject to EFH consultation (PFMC 1998).

Before the late 1980s, the starry flounder was common in both the commercial and recreational fisheries of northern and central California (DFG 2001). Historically, most of the commercial catch was made by bottom trawl; however, during the 1980s, many starry flounders were also taken by gill and trammel nets in central California. Commercial landings declined sharply during the late 1980s and remained at relatively low levels through the 1990s. From 1992 through 1999, landings averaged only 62,225 pounds, ranging from a low of 25,353 pounds in 1995 to a high of 100,309 pounds in 1999. This is in contrast to annual landings of more than a million pounds during the 1970s and half a million pounds in the 1980s. The recreational catch of starry flounders is from piers, boats, and shore, usually in estuarine and adjacent coastal waters. The estimated annual recreational catch for this species in California from 1981 to 1989 averaged 40,000 fish. Recreational catches, like commercial landings, declined dramatically during the 1990s. Catch estimates from 1993 through 1999 averaged 6,000 fish per year, ranging from a high in 1998 of 15,000 fish to lows in 1994 and 1996 of 3,000 fish.

Starry flounders range from Korea and Japan north to the Bering and Chukchi seas and the coast of Alaska to southern California, although they are uncommon south of Point Conception. The starry flounder is primarily a coastal species, living on sand and mud bottoms and avoiding rocky areas. Though found to depths of 900 feet, this species is much more common in shallower waters. Starry flounders are frequently found in bays and estuaries and are tolerant of brackish water and freshwater. Tagging studies have not demonstrated extensive migrations, although there is some movement along the shore. Seasonal onshore-offshore movements of these fish possibly related to spawning are assumed to occur.

Starry flounder can be found in Suisun Bay and the lower portion of the San Joaquin River in the Delta. The distribution of the starry flounder tends to shift with growth. Young juveniles are commonly found in freshwater or brackish water of Suisun Bay, Suisun Marsh, and the Delta; older juveniles range from brackish to marine water of Suisun and San Pablo bays; and adults tend to live in shallow marine waters within and outside San Francisco Bay before returning to estuaries to spawn (Reclamation 2008a).

Life History

Most spawning by the starry flounder occurs in shallow waters near the mouths of rivers and estuaries during the winter. In central California, December and January are the peak months of spawning. Metamorphosis from larvae to juvenile occurs 39 days to 75 days after hatching. Females grow faster and reach larger sizes than do males. In central California, most males are sexually mature at 2 years and an average 14.5 inches, and most females mature at 3 years and 16 inches. The maximum size reported is 36 inches.

Starry flounder larvae feed on planktonic organisms, while young juveniles feed primarily on copepods and amphipods. As they grow, their diet changes. Five-inch fish have developed jaws and teeth that allow them to crush small clams and pull worms from their burrows. Sand dollars, brittle stars, and fish are included in the diets of larger starry flounders. Historically, in San Francisco Bay, small starry flounder fed mainly on opossum shrimp until the invasion of the overbite clam (*Potamocorbula amurensis*) caused a major reduction in shrimp abundance, forcing starry flounders to switch to a more diverse diet (Reclamation 2008a). Wading and diving seabirds such as herons and cormorants, as well as marine mammals such as harbor seals, feed on juvenile starry flounders in estuaries. On occasion, a fish is caught that displays physical characteristics intermediate between those of a starry flounder and an English sole; such a fish may be a hybrid of those species.

Habitat Requirements

Although the starry flounder is considered a euryhaline fish, a USFWS study using fyke nets to capture salmon and striped bass took starry flounder in freshwater portions of the Delta. Eighty starry flounder were taken in the San Joaquin River one-half mile downstream from the Antioch Bridge (Reclamation 2008a). Salinity at this location during the April to September period of the study varied from about 0.06 ppt to 9.0 ppt, a variation from freshwater to brackish water with salinity about one-quarter that of the ocean. A total of 193 starry flounder were captured in the Sacramento River at Rio Vista, where the salinity varied from 0.02 ppt to 0.5 ppt.

Starry flounder generally prefer tidal, low-gradient areas that have sandy or muddy bottoms (Reclamation 2008a). Most starry flounder found in freshwater are YOY. Abundance of starry flounder may be lower during dry years, but young are more likely to be found farther upstream, where they are vulnerable to entrainment by the pumps in the south Delta (Moyle 2002). The smallest fish are generally found farthest upstream and seek areas with higher salinity as they grow (Reclamation 2008a). Thus, from April to June, most YOY are living in salinities of less than 2 ppt, but by July and August they have shifted to salinities of 10 ppt to15 ppt. Water temperatures may also influence distribution because starry flounder are usually found at 50°F to 68°F. Starry flounders less than about 8 inches in length encountered in freshwater are likely mostly migrants from salt water, rather than fish that have reared there (Moyle 2002).

In the San Francisco estuary, some smaller flounders may have originated from spawning within the estuary, but most are apparently carried into San Francisco Bay from nearshore ocean waters by strong tidal currents along the bottom (Reclamation 2008a). These currents are strongest during years of high outflow from the rivers; consequently, juvenile starry flounder tend to be most abundant in the estuary during wet years (Moyle 2002). Greater abundance may be related to the greater extent of low-salinity rearing areas and the greater abundance of food organisms preferred by small flounder. Summertime abundance of YOY starry flounder in San Francisco Bay is closely related to discharge into the bay during the previous winter (Reclamation 2008a).

Population Decline

No studies have been conducted to determine the population size of the starry flounder, but commercial landing and recreational catch trends suggest that the California population is now at extremely low levels. Reasons for the decline are uncertain, but fishing pressure is likely a factor. Moyle (2002) suggests that the decline may be related to changing estuarine conditions or to changes in fishing regulations that reduce catch.

SWP/CVP fish salvage facilities in the Delta recorded average monthly salvage records for the starry flounder for the 1981 to 2002 period as 187 fish per month at the CVP pumps and 77 at the SWP pumps (Reclamation 2008a). The large population decline suggested by fishery trends is substantiated by a fishery-independent trawl survey conducted by DFG in the San Francisco estuary from 1980 through 1995. Results of this survey show the abundance of age-0 and age-1+ starry flounder dropping dramatically during the late 1980s and remaining at low levels through the 1990s (DFG 2001). Recruitment is determined largely by survival of larval and juvenile fish. Given the importance of bays and estuaries to the young of this species, the continued environmental health of these areas may be the most important factor in maintaining healthy populations of starry flounder.

5.3 Terrestrial Species

5.3.1 Plants

Federally listed plant species that would be affected by the Proposed Action are described individually below. Known occurrences of federally listed plant species near the Restoration Area are shown in Figures 5-1 through 5-3 (California Natural Diversity Database (CNDDB) 2011). Designated critical habitat and recovery units for listed plant species are shown in Figures 5-4 and 5-5, respectively.

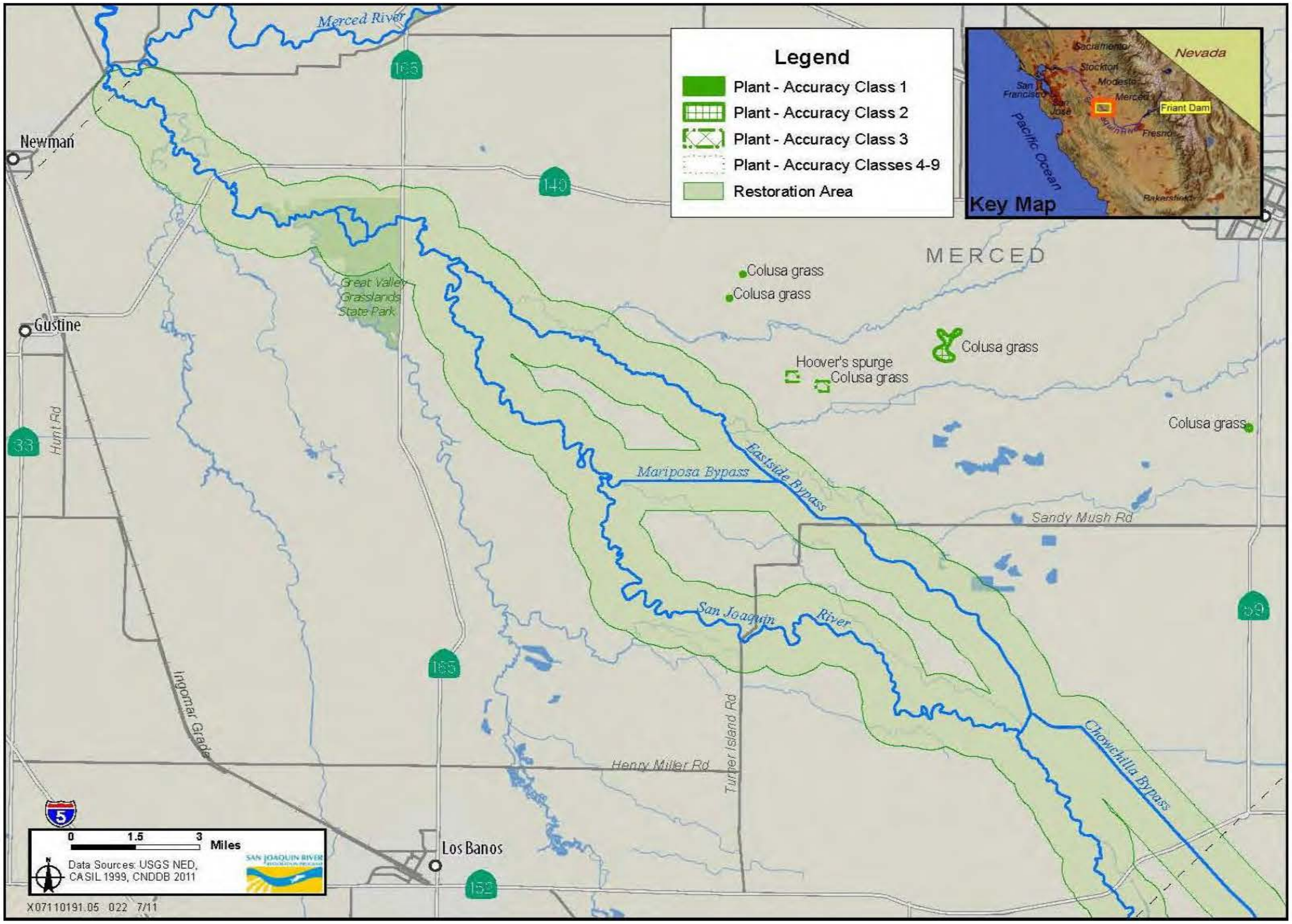

Figure 5-1.
Occurrences of Federally Listed Plants In Action Area

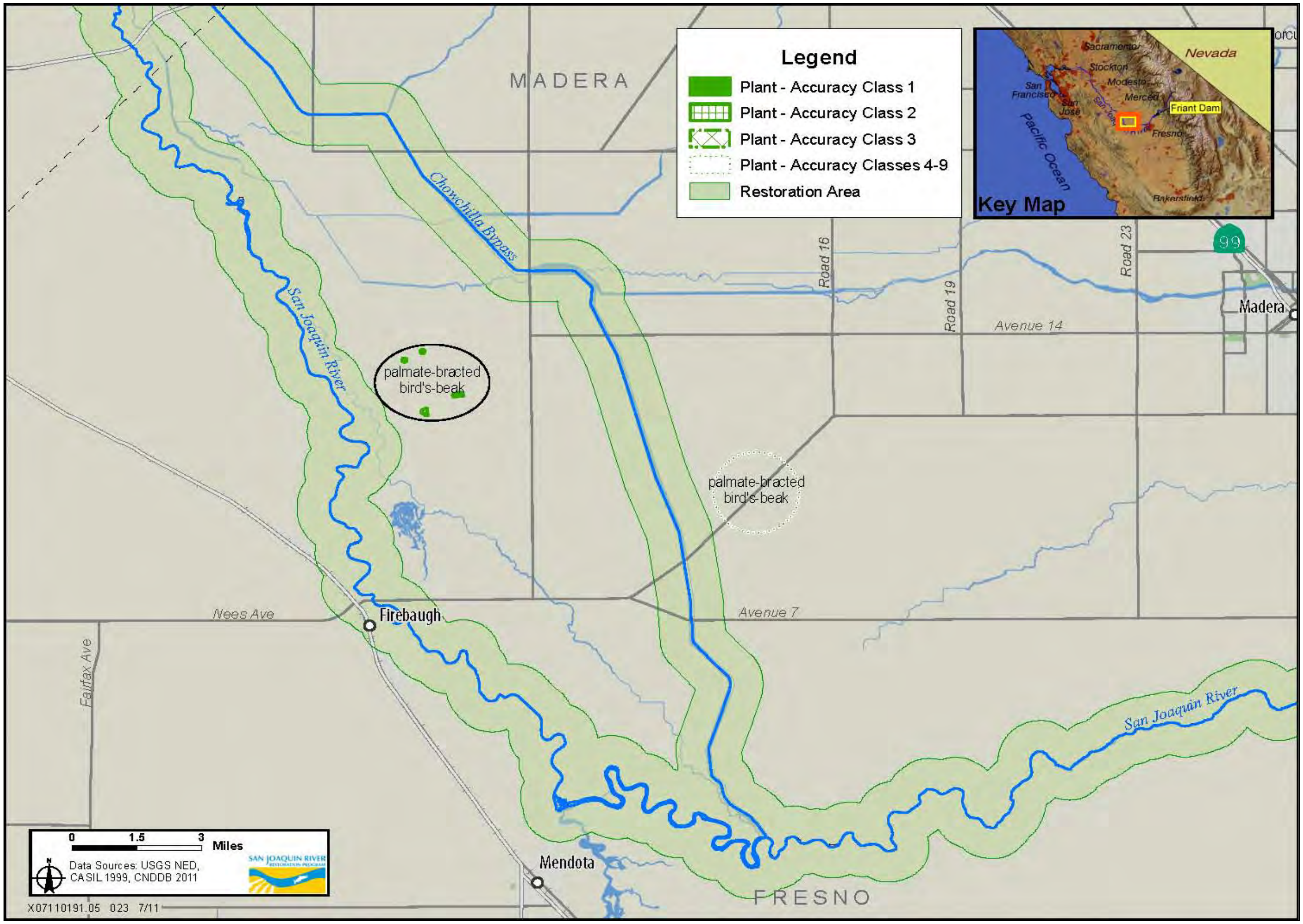

Figure 5-2.
Occurrences of Federally Listed Plants In Action Area

Figure 5-3.
Occurrences of Federally Listed Plants In Action Area

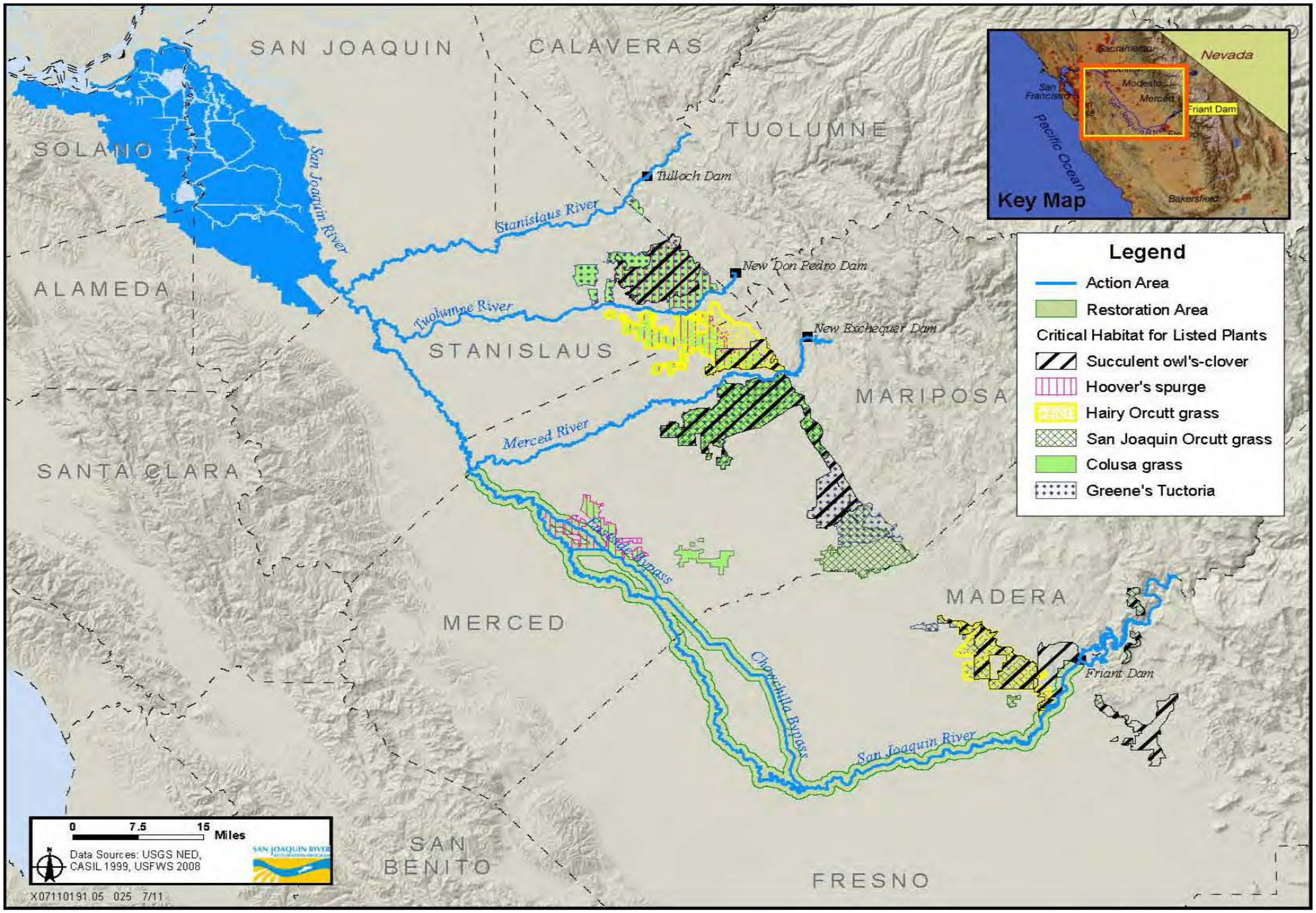

Figure 5-4.
Critical Habitat for Federally Listed Plants in Action Area

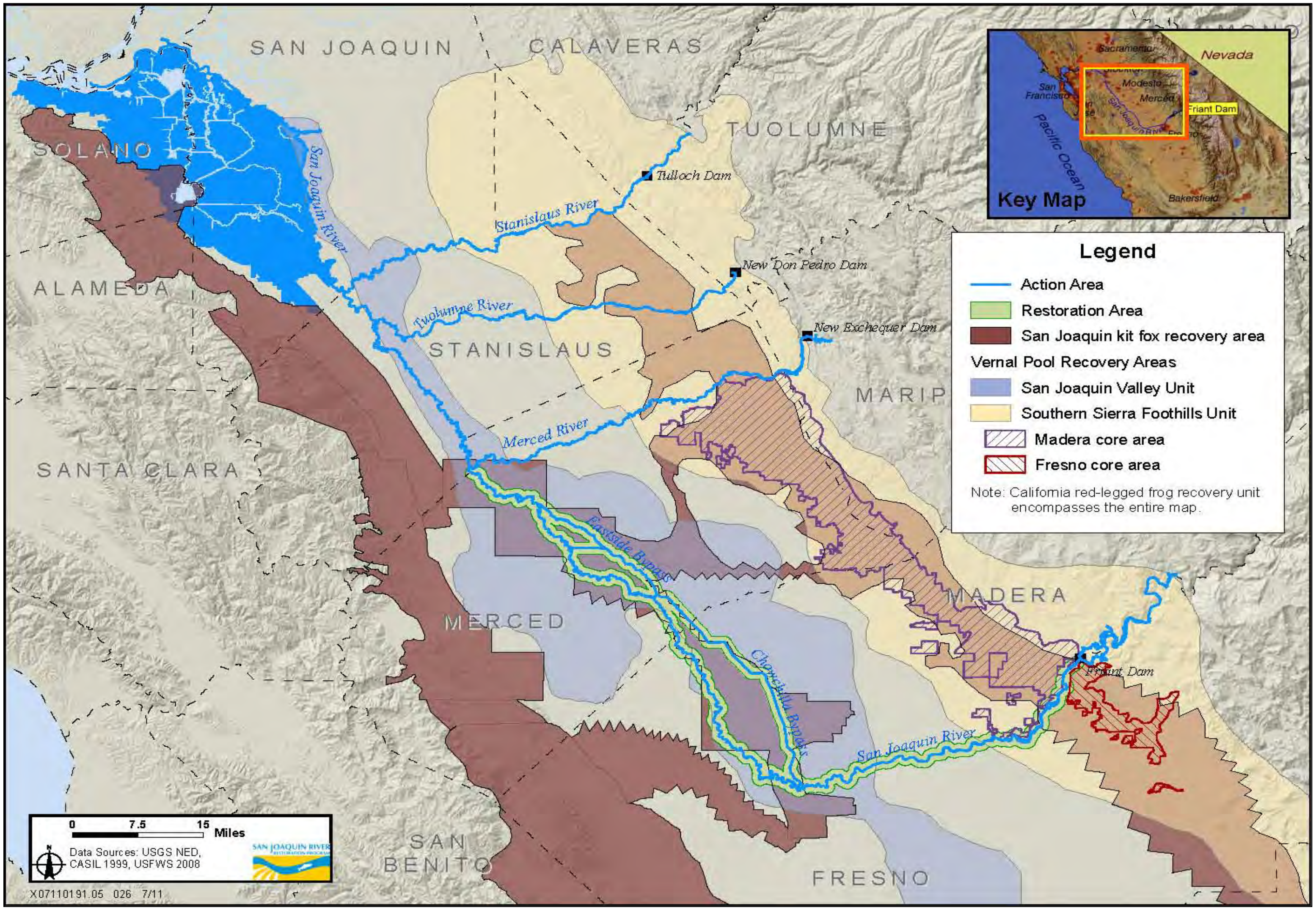

Figure 5-5.
Recovery Areas for Federally Listed Species in Action Area

Succulent Owl's-Clover

Succulent owl's-clover, which is Federally listed as threatened, occurs in vernal pool habitat, often in acidic conditions. This species is discontinuously distributed through the southern Sierra Nevada foothills and eastern San Joaquin Valley in Fresno, Madera, Merced, Mariposa, San Joaquin, and Stanislaus counties at elevations of 160 feet to 2,500 feet above mean sea level. Succulent owl's-clover has been documented near but not within the Restoration Area, with two occurrences documented just outside of the Restoration Area boundary in Reach 1 (CNDDB 2011). One of these occurrences, last observed in 1938, may have been extirpated because the site had been disked and the species was absent when a visit to relocate the occurrence was made in 1981. Critical habitat for succulent owl's-clover is designated in and immediately adjacent to the Restoration Area in Reach 1A (Figure 5-4). Urbanization, agriculture, and flood control are the primary threats to this species (California Native Plant Society (CNPS) 2009). Grazing and trampling are frequently suggested as threats, but some level of grazing may benefit this species by controlling nonnative competitors.

Succulent owl's-clover is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool–associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

Hoover's Spurge

Hoover's spurge, which is Federally listed as threatened, is discontinuously distributed in the Central Valley in Tehama, Glenn, Butte, Colusa, Stanislaus, Merced, and Tulare counties. This species' elevation range is 80 feet to 820 feet above mean sea level. Hoover's spurge, a small, prostrate annual herb species, is found in relatively large, deep vernal pools among the rolling hills, remnant alluvial fans, and depositional stream terraces of the eastern Sacramento and San Joaquin valleys (Stone et al. 1988, cited in USFWS 2005a). The species has been documented near but not within the Restoration Area. Critical habitat for Hoover's spurge is designated in and immediately adjacent to the Restoration Area in Reaches 4B1 and 4B2 (Figure 5-4). Conversion of habitat to agricultural land uses, competition from nonnative species, and grazing are recognized as threats to Hoover's spurge (CNPS 2009), although some level of grazing may benefit this species by controlling nonnative competitors.

Hoover's spurge is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool-associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

Palmate-Bracted Bird's-Beak

Palmate-bracted bird's-beak is Federally listed as endangered, with only seven known populations: four in the Sacramento Valley, one in the Livermore Valley, and two in the San Joaquin Valley. This species' elevation range is 15 feet to 500 feet above mean sea level. Palmate-bracted bird's-beak grows in alkaline soils in chenopod scrub and valley and foothill grassland habitat, primarily at the edges of channels, with individuals scattered in seasonally wet depressions, alkali scalds, and grassy areas (USFWS 1998a, cited in McBain and Trush 2002). Palmate-bracted bird's-beak has been documented near but not within the Restoration Area, including at the Alkali Sink Ecological Area and Mendota NWR, approximately 4 miles south of Reach 2A, and between the San Joaquin River and the Chowchilla Bypass near Reach 3. This species is threatened by agricultural conversion, urbanization, industrial development, off-road vehicles, modified hydrology, and grazing.

Palmate-bracted bird's-beak is covered by the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a), with recovery units that include portions of the Action Area (Figure 5-5). The recovery strategy for palmate-bracted bird's-beak is focused on maintaining self-sustaining populations in preserved areas, protecting existing populations on private land, surveying historical occurrences, and reintroducing the species in areas where it has been extirpated.

Colusa Grass

Colusa grass, which is Federally listed as threatened, is known from approximately 40 populations in Merced, Stanislaus, Solano, and Yolo counties, including occurrences in and near the Arena Plains Unit of the San Luis NWR Complex. This species has been found in northern claypan and northern hardpan pool types at elevations ranging from 15 feet to 4,000 feet above mean sea level. It grows in large or deep vernal pools that retain water until late spring (Stone et al. 1988, cited in USFWS 2005a); these pools usually have adobe clay soils. Colusa grass has been documented near but not within the Restoration Area. Critical habitat is designated for this species and is located in and adjacent to Reaches 4B1 and 4B2 (Figure 5-4). The biggest threat to survival of Colusa grass is conversion of habitat to agricultural land uses. Development, flood control, overgrazing, and competition from nonnative species are also recognized threats. Other observed threats at specific sites include poultry manure, herbicides, and groundwater contamination by industrial chemicals (USFWS 2005a).

Colusa grass is covered by the Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool-associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

San Joaquin Valley Orcutt Grass

San Joaquin Valley Orcutt grass, which is Federally listed as endangered, is restricted to the vernal pool region of the eastern San Joaquin Valley, from Stanislaus County to Tulare County, at elevations up to 2,500 feet. A small, grayish green, tufted annual of the grass family, San Joaquin Valley Orcutt grass is found on alluvial fans, stream terraces, and tabletop lava flows in northern claypan, northern hardpan, and northern basalt flow vernal pools. The species grows primarily in large pools that retain water until late spring (Stone et al. 1988, cited in USFWS 2005a). Most of the extant occurrences are concentrated in two small areas of eastern Merced County: an occurrence that overlaps with the Restoration Area in Reach 1A and another located just outside the Restoration Area boundary on the east side of Friant Road. Survival of San Joaquin Valley Orcutt grass is seriously threatened by agricultural conversion, urbanization, overgrazing, channelization and other hydrological modifications, and competition from nonnative plants (CNPS 2009; USFWS 2005a). Grasshopper herbivory during large outbreaks threatens some populations. Critical habitat for this species is designated adjacent to Reach 1A (Figure 5-4).

San Joaquin Valley Orcutt grass is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool–associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

Hairy Orcutt Grass

Hairy Orcutt grass, which is Federally listed as endangered, has a discontinuous distribution through the Central Valley and southern Sierra Nevada foothills. Northern populations are located in Tehama, Glenn, and Butte counties and southern populations are found in Madera, Merced, and Stanislaus counties. The elevation range of hairy Orcutt grass is 175 feet to 650 feet above mean sea level. This species is found in vernal pools in undulating topography on remnant alluvial fans and stream terraces. The species grows primarily in large pools that retain water until late spring (Stone et al. 1988, cited in USFWS 2005a). Hairy Orcutt grass has been documented near the Restoration Area in the Gregg, Herndon, Lanes Bridge, and Madera quadrangles. There are no known occurrences in the Restoration Area; the nearest documented occurrence (CNDDB Occurrence 28) is located approximately 3,000 feet outside the Reach 1A boundary. Critical habitat for this species is designated in and immediately adjacent to Reach 1A (Figure 5-4). The biggest threats to the survival of hairy Orcutt grass are habitat conversion to agricultural uses and development (CNPS 2009). Cattle grazing and competition from nonnative species are additional recognized threats. Some populations are vulnerable to extinction from random catastrophic events (e.g., fire, flood, insect infestations) because of their small sizes.

Hairy Orcutt grass is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool–associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

Greene's Tuctoria

Greene's tuctoria, which is Federally listed as endangered, is discontinuously distributed throughout the Central Valley and Sierra Nevada foothills, with populations in Shasta, Tehama, Butte, Glenn, and Merced counties. Historically, this species also was found in San Joaquin, Stanislaus, Madera, and Tulare counties, but known occurrences in these counties are believed to be extirpated (USFWS 2005a). There is a single population of this species in Shasta County at an elevation of 3,500 feet, but the remaining current and historically known occurrences range in elevation from 110 feet to 440 feet above mean sea level. This species is found in northern hardpan, northern claypan, and northern basalt flow vernal pools of intermediate size and typically is found in shallower pools than other species in the Orcuttiaea tribe (i.e., grasses in the Orcutt tribe, which also includes the Orcutt grasses and Colusa grass) or grows at the shallow edges of deeper pools (USFWS 2005a). Greene's tuctoria has not been documented in the Action Area, but it was historically known from vernal pool habitat near the Stanislaus and Tuolumne rivers, and critical habitat for this species has been designated in the Action Area along these rivers (Figure 5-4). As with other vernal pool plant species, the biggest threat to Greene's tuctoria is loss of habitat related to agricultural and urban land use conversion. Grasshopper infestations also may pose a threat to this species (USFWS 2005a). Observers have documented entire populations of Greene's tuctoria being eaten by grasshoppers before they were able to produce seed (Griggs 1980, cited in USFWS 2005a; Griggs and Jain 1983, cited in USFWS 2005a; Stone et al. 1988, cited in USFWS 2005a).

Greene's tuctoria is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a) and recovery units include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool-associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

5.3.2 Wildlife

Federally listed wildlife species that would be affected by the Proposed Action are described individually below. Known occurrences of Federally listed wildlife species near the Restoration Area are shown in Figures 5-6 through 5-8 (CNDDB 2011). Designated critical habitat for listed wildlife species is shown in Figures 5-9.

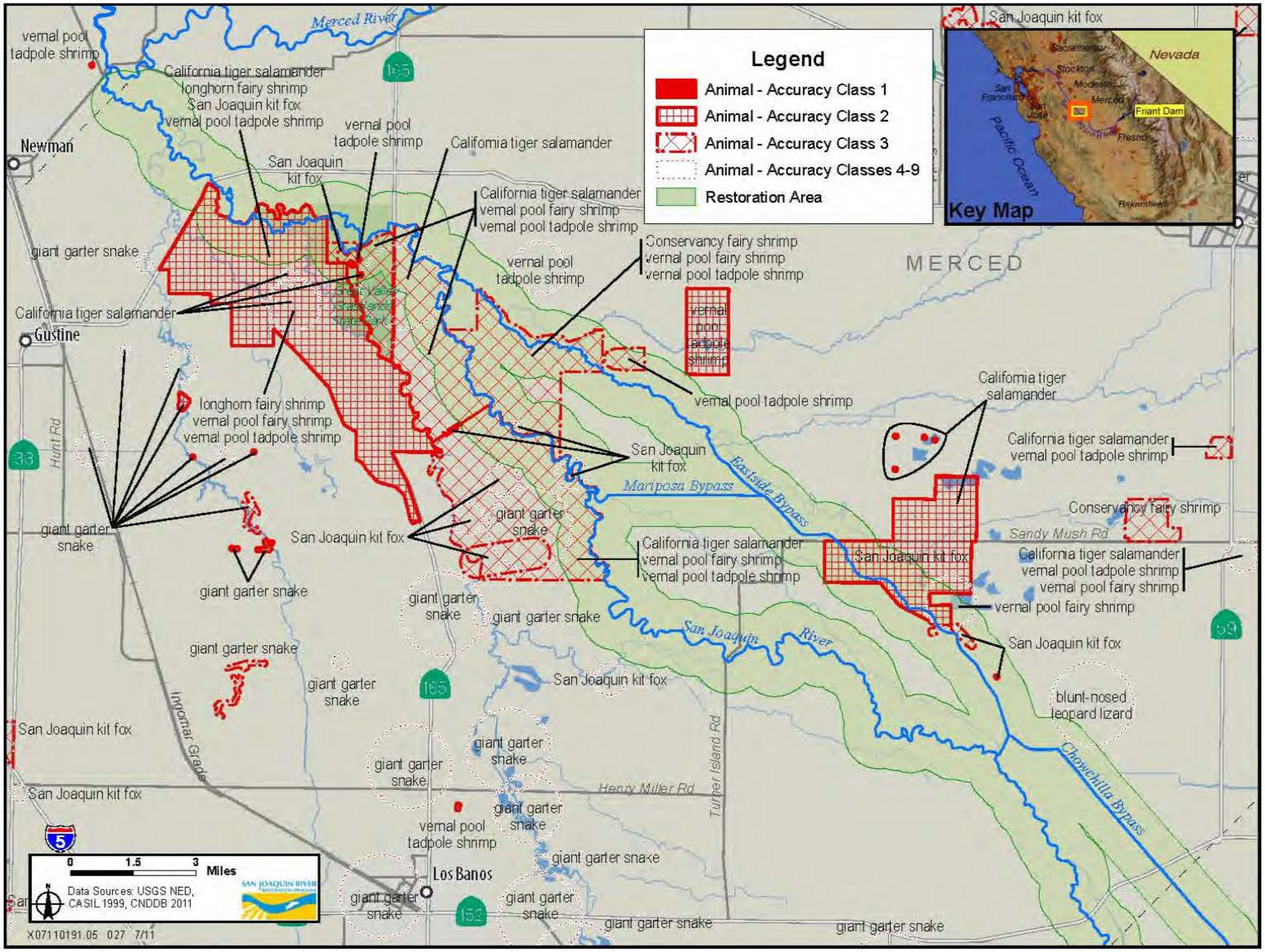

Figure 5-6.
Occurrences of Federally Listed Wildlife In Action Area

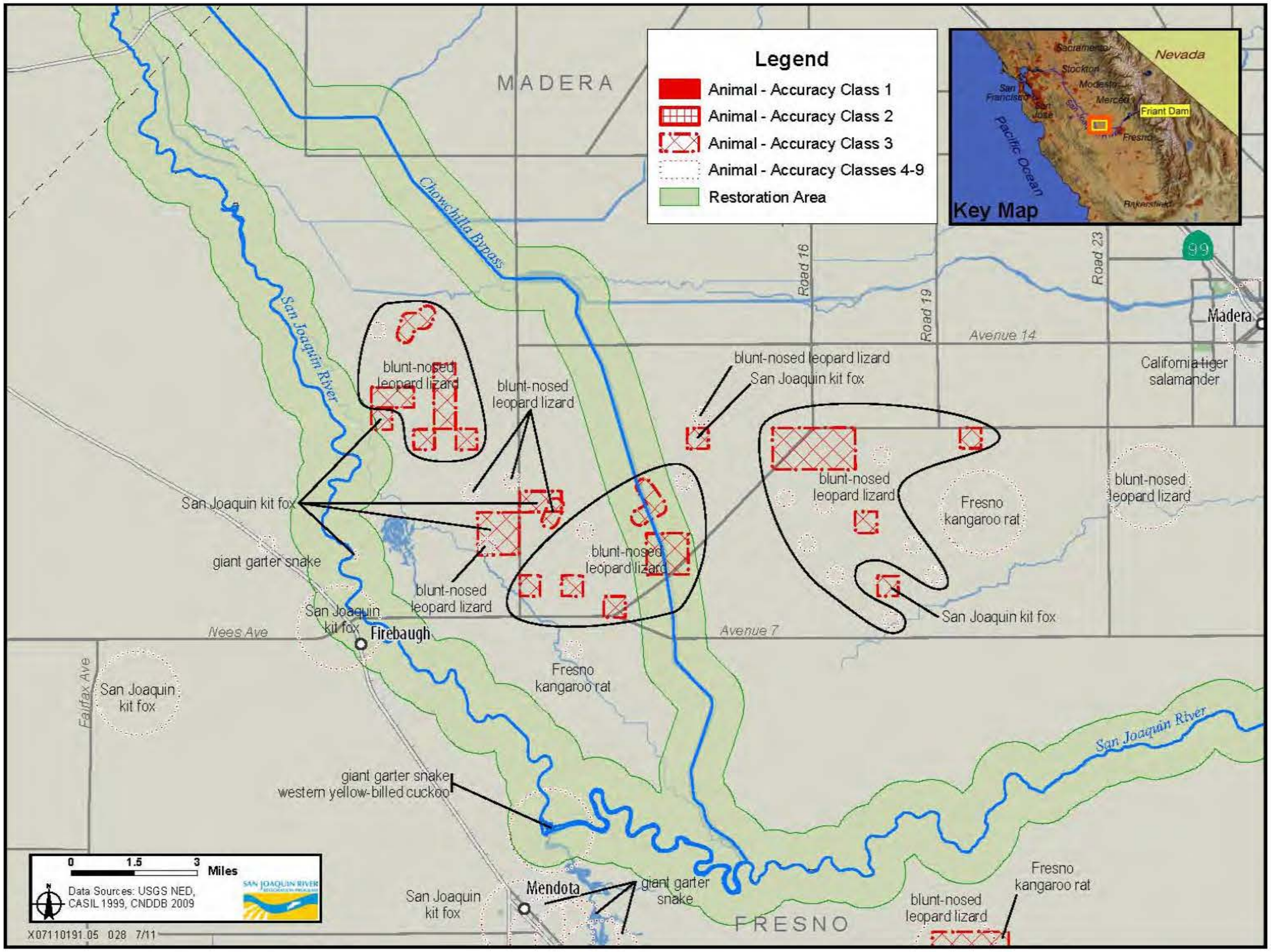

Figure 5-7.
Occurrences of Federally Listed Wildlife In Action Area

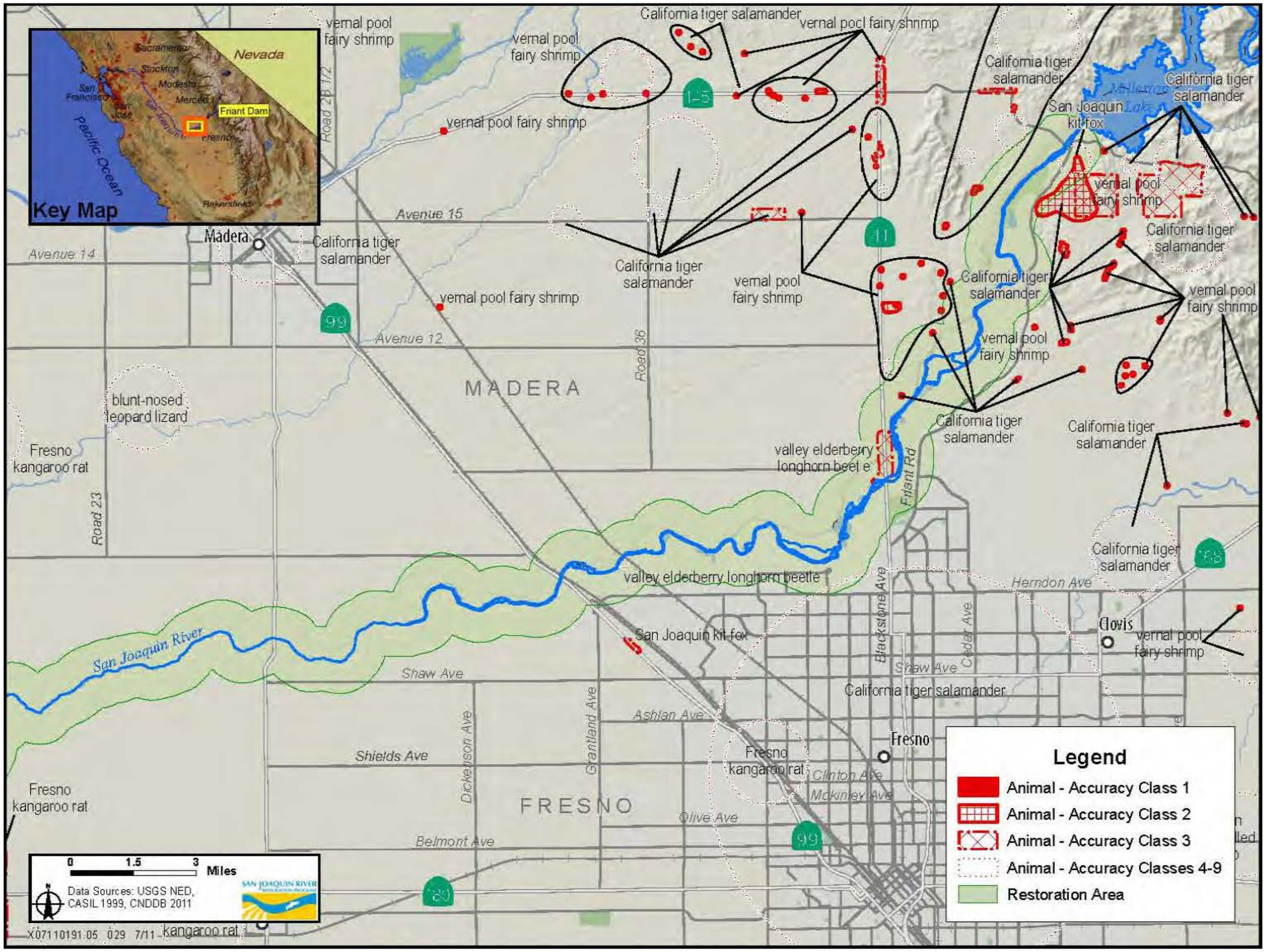

Figure 5-8.
Occurrences of Federally Listed Wildlife In Action Area

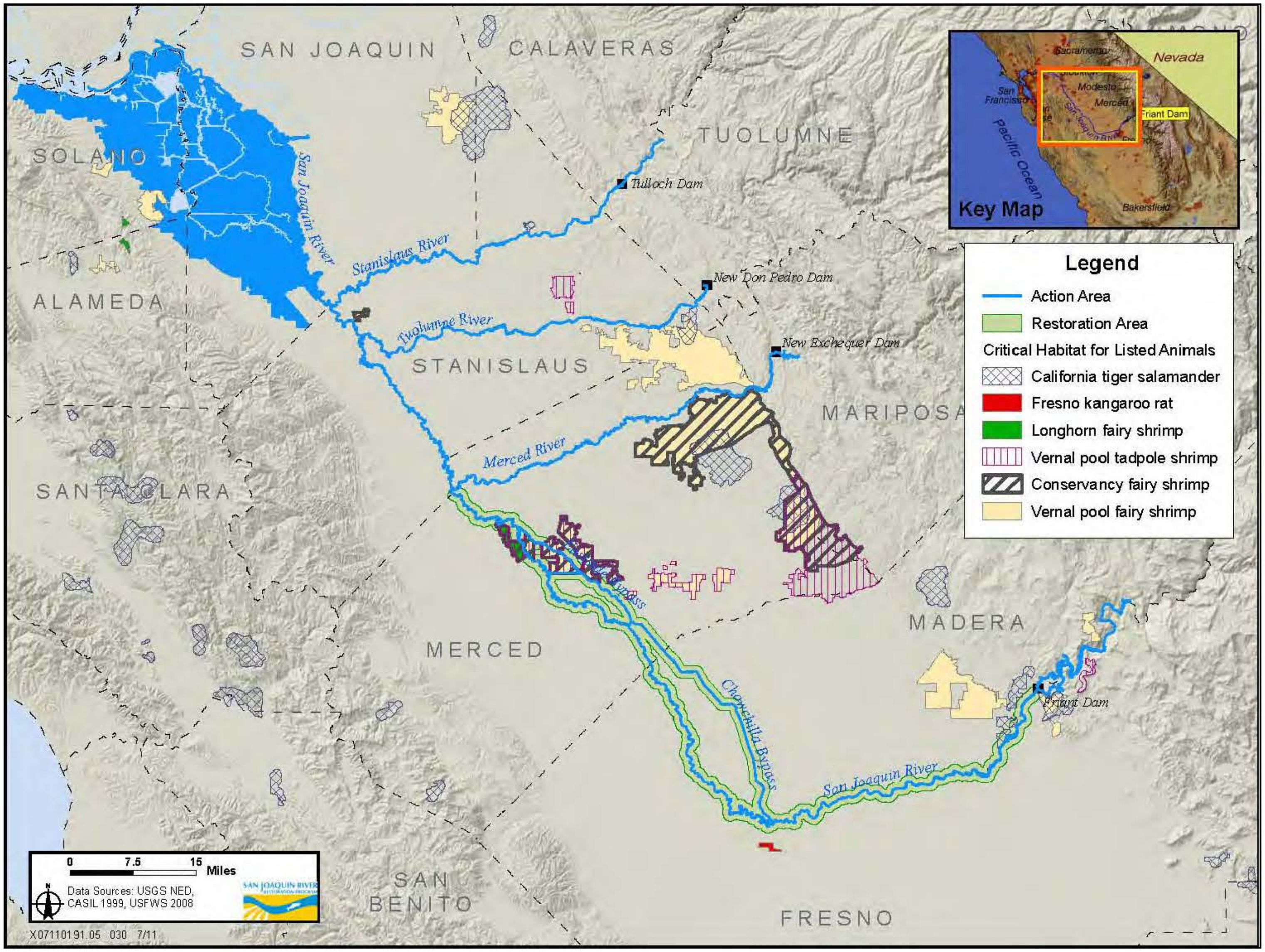

Figure 5-9.
Critical Habitat for Federally Listed Wildlife in Action Area

Conservancy Fairy Shrimp

Conservancy fairy shrimp is Federally listed as endangered. This species' range extends from the northern Sacramento Valley to the San Joaquin Valley. Conservancy fairy shrimp occurs in vernal pools, swales, and lakes (Helm 1998) that are relatively large (more than several acres in size) and turbid (Eriksen and Belk 1999; Helm 1998; King 1996). The species is known to occur in suitable habitat in the San Luis NWR Complex in Reaches 4B2 and 5 and the Eastside Bypass. Designated critical habitat for Conservancy fairy shrimp is in and adjacent to the Chowchilla, Eastside and Mariposa bypasses as well as Reaches 4B2 and 5 (Figure 5-9).

Vernal pool and seasonal wetlands suitable for this species are not likely to be present in the San Joaquin River corridor (e.g., between the existing banks or levees) of the Restoration Area. The presence of suitable vernal pool or seasonal wetland habitat in the Chowchilla, Eastside, and Mariposa bypasses is unknown. These bypasses were created in uplands that historically contained northern claypan vernal pools; however, natural vernal pools were eliminated from many areas by land conversion for agricultural development and the subsequent hydrologic modification that occurred when the bypasses, agricultural diversions, and discharge areas were created. Still, because soils in the area have a high clay content, depressions caused by previous construction activities in upland habitats still tend to hold rainwater for an extended period. As a result, soil and hydrologic conditions may be suitable to support vernal pool invertebrates in some areas. A reconnaissance-level survey of the Eastside Bypass conducted in February and March 2000 (DFG 2000) suggested, however, that existing conditions in these low-flow channel bypasses are unlikely to be suitable for vernal pool invertebrates because the channel is regularly inundated during seasonal flood flows.

The Conservancy fairy shrimp is threatened primarily by habitat loss and fragmentation resulting from expansion of agricultural and developed land uses. Vernal pool habitat also can be lost or degraded by other activities that damage or puncture the hardpan (i.e., water-restrictive layer underlying the pool) or by activities that destroy or degrade uplands that contribute water to vernal pools. In addition to habitat conversion, activities causing such loss or degradation include deep ripping of soils; water diversion or impoundment; and application of pesticides, fertilizers, or livestock wastes. Additional threats are incompatible grazing practices, replacement of native plants by nonnative species, and introduction of fish to vernal pools (Robins and Vollmar 2002; Marty 2005; Pyke and Marty 2005; USFWS 2005a).

The Conservancy fairy shrimp is covered by the *Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This recovery plan addresses a large number of vernal pool–associated species through an ecosystem approach to recovery that is focused on habitat protection and management. This species has been or is proposed to be covered by several regional HCPs.

Longhorn Fairy Shrimp

Longhorn fairy shrimp is Federally listed as endangered. This species' known distribution extends from Contra Costa and Alameda counties to San Luis Obispo County and also includes Merced County (USFWS 2005a; CNDDB 2011). Within this geographic range, the longhorn fairy shrimp is extremely rare in vernal pools and swales. The species is known to occur in suitable habitat in the San Luis NWR Complex in Reach 5. Designated critical habitat for this species is in and adjacent to Reaches 4B2 and 5 (Figure 5-9).

Similar to the Conservancy fairy shrimp, vernal pool and seasonal wetlands suitable for the longhorn fairy shrimp are not likely to be present in the San Joaquin River corridor (e.g., between the existing banks or levees) of the Restoration Area or in the Chowchilla, Eastside, and Mariposa bypasses.

The longhorn fairy shrimp has likely experienced habitat loss and fragmentation as a result of the expansion of agricultural and developed land uses. However, this species is now threatened by habitat loss and disturbance resulting from several site-specific activities at the few locations from which it is known: wind energy development, a water storage project, construction of a dirt access road, and land management activities (USFWS 2005a). Additional threats to longhorn fairy shrimp may include incompatible grazing practices and replacement of native plants by nonnatives (Robins and Vollmar 2002; Marty 2005; Pyke and Marty 2005).

Like the Conservancy fairy shrimp, the longhorn fairy shrimp is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). In addition, much of the species' known occupied habitat has been partially or fully protected on land managed by the East Bay Regional Park District, USFWS, and the Carrizo Plain National Monument.

Vernal Pool Fairy Shrimp

Vernal pool fairy shrimp, which is Federally listed as threatened, is found throughout the Central Valley and west to the central Coast Ranges, at sites 30 feet to 4,000 feet in elevation (USFWS 2005a). The species has also been reported from the Agate Desert region of Oregon near Medford; disjunct populations occur in San Luis Obispo, Santa Barbara, and Riverside counties. Within this geographic range, the vernal pool fairy shrimp inhabits primarily vernal pools (Eng et al. 1990). The species also occurs in other wetlands that provide habitat similar to vernal pools: alkaline rain-pools, ephemeral drainages, rock outcrop pools, ditches, stream oxbows, stock ponds, vernal swales, and some seasonal wetlands (Helm 1998). Occupied wetland habitats range in size from several square feet to more than 10 acres. This species is not found in riverine or other permanent waters. The vernal pool fairy shrimp is known to occur in suitable habitat in the San Luis NWR Complex in Reaches 4B1, 4B2, and 5 and in the Chowchilla and Eastside bypasses. Critical habitat for this species is near Reach 1A and adjacent to the Chowchilla, Eastside, and Mariposa bypasses as well as Reaches 4B2 and 5 (Figure 5-9). Similar to the Conservancy fairy shrimp, vernal pool and seasonal wetlands suitable for vernal pool fairy shrimp are not likely to be present in the San Joaquin River corridor (e.g., between the existing banks or levees) in the Restoration Area or in the Chowchilla, Eastside, and Mariposa bypasses. The threats to the survival of the vernal pool fairy shrimp are similar to those of the Conservancy fairy shrimp, described above.

Like the Conservancy fairy shrimp, the vernal pool fairy shrimp is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). The vernal pool fairy shrimp has been or is proposed to be covered by several regional HCPs.

Vernal Pool Tadpole Shrimp

The vernal pool tadpole shrimp, which is Federally listed as endangered, is endemic to the Central Valley, with most populations in the Sacramento Valley. This species has also been reported from the Delta to the east side of San Francisco Bay, and from scattered localities in the San Joaquin Valley from San Joaquin County to Madera County (Rogers 2001). Within this geographic range, vernal pool tadpole shrimp occur in a wide variety of seasonal habitats: vernal pools, ponded clay flats, alkaline pools, ephemeral stock tanks, and roadside ditches (CNDDB 2011; Helm 1998; Rogers 2001). Habitats where vernal pool tadpole shrimp have been observed range in size from small, clear, vegetated vernal pools to highly turbid pools to large winter lakes (Helm 1998; Rogers 2001). This species has not been reported in pools that contain high concentrations of sodium salts, but it may occur in pools with high concentrations of calcium salts. Vernal pool tadpole shrimp are known to occur in suitable habitat in the San Luis NWR Complex; at the Great Valley Grasslands State Park in Reaches 4B1, 4B2, and 5; and in and adjacent to the Chowchilla and Eastside bypasses. Critical habitat for this species is in and adjacent to the Chowchilla, Eastside, and Mariposa bypasses as well as Reaches 4B2 and 5 (Figure 5-9). Similar to the Conservancy fairy shrimp, vernal pool and seasonal wetlands suitable for the vernal pool tadpole shrimp are not likely to be present in the San Joaquin River corridor (e.g., between the existing banks or levees) of the Restoration Area or in the Chowchilla, Eastside, and Mariposa bypasses. The threats to the survival of the vernal pool tadpole shrimp are similar to those of the Conservancy fairy shrimp, described above.

The vernal pool tadpole shrimp is covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a), with recovery units that include portions of the Action Area (Figure 5-5). This species has been or is proposed to be covered by several regional HCPs.

Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle is Federally listed as threatened; however, in 2006, USFWS recommended that this species be delisted (USFWS 2006a). Endemic to the Central Valley, this beetle is found only in association with its host plants, the elderberry shrub (*Sambucus spp.*). In the Central Valley, the elderberry shrub is found primarily in riparian vegetation. The valley elderberry longhorn beetle is known to occur in elderberry shrubs present in the riparian woodland in Reaches 1A and 2, and is expected to occur in suitable habitat in other locations in the Restoration Area. Elderberry shrubs are associated with riparian habitats and typically are located on the higher portions of levees and streambanks, which are not subject to inundation or scouring, although some in the Action Area were noted to be growing along the channel (ESRP 2004, 2006). The valley elderberry longhorn beetle has experienced substantial loss of riparian habitat containing its host plant, along with damage to and loss of host plants in remaining habitat. However, the species' greatest current threat may be predation and displacement by the invasive Argentine ant (*Linepithema humile*) (Huxel 2000).

A recovery plan was prepared for the valley elderberry longhorn beetle during the 1980s (USFWS 1984). Regularly implemented conservation measures have included avoidance and minimization of effects on occupied habitat, elderberry transplantation and replacement plantings, and habitat preservation. In part as a result of these measures, extensive areas of habitat have been preserved (USFWS 2006a). As noted above, the species has been recommended for delisting.

California Tiger Salamander

California tiger salamander is Federally listed as threatened throughout its range except in Sonoma and Santa Barbara counties, where it is listed as endangered (69 FR 47212–47248, August 4, 2004; 70 FR 49379–49458, August 23, 2005). The Proposed Action is located within the range of the central population of California tiger salamander (70 FR 49379–49458). The species, endemic to California, ranges across the Central Valley and the eastern foothills of the Sierra Nevada from Yolo County (possibly up to Colusa County) south to Kern County, and coastal grasslands from Sonoma County to Santa Barbara County at elevations ranging from approximately 10 feet to 3,500 feet above mean sea level (Shaffer and Fisher 1991). The California tiger salamander requires vernal pools, ponds (natural or human-made), or semipermanent calm waters (where ponded water is present for a minimum of 3 months to 4 months) for breeding and larval maturation. The species also requires adjacent upland areas that contain small-mammal burrows or other suitable refugia for aestivation. Surveys have detected the presence of California tiger salamander at the West Bear Creek Unit of the San Luis NWR Complex and at Great Valley Grasslands State Park (McBain and Trush 2002). Critical habitat for this species is in and adjacent to Reach 1A (Figure 5-9).

The survival of the California tiger salamander can be threatened by alteration of either breeding ponds or upland habitat through introduction of exotic predators (e.g., bullfrogs (*Rana catesbeiana)* and mosquitofish (*Gambusia affinis*) or construction of barriers that fragment habitat and reduce connectivity (e.g., roads, berms, and certain types of fences) (Jennings and Hayes 1994; Trenham et al. 2001). Other threats include vehicle-related mortality, especially during breeding migrations (Barry and Shaffer 1994), and rodent-control programs, which lead to loss of aestivation habitats (Loredo et al. 1996).

A recovery plan for California tiger salamander has not been prepared, and this species is not covered by the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005a). However, the recovery plan addresses a large number of vernal pool-associated species through an ecosystem approach focused on habitat protection and management. Thus, the California tiger salamander likely will benefit from many of these recovery actions.

Blunt-Nosed Leopard Lizard

Blunt-nosed leopard lizard, which is Federally listed as endangered, was historically found throughout the San Joaquin Valley and adjacent foothills, from San Joaquin County to eastern San Luis Obispo County. This species currently occupies isolated and scattered areas of undeveloped habitat on the San Joaquin Valley floor and in the eastern foothills of the Coast Ranges. Blunt-nosed leopard lizards are found in areas with sandy soils and scattered vegetation and usually are absent from thickly vegetated habitats (DFG 1992b). On the floor of the San Joaquin Valley, they usually are found in nonnative grassland, valley sink scrub habitats, valley needlegrass grassland, alkali playa, and valley saltbush scrub (USFWS 1998a). There are several records of blunt-nosed leopard lizard occurring near Mendota Pool. This species is also known to occur in the Chowchilla Bypass and could occur in the Eastside and Mariposa bypasses if suitable habitat is present. It is not expected to occur in the San Joaquin River corridor or the existing low-flow channel of the bypasses because these areas are regularly inundated during seasonal flood flows.

Habitat disturbance, fragmentation, and loss are the greatest threats to populations of blunt-nosed leopard lizard (USFWS 1998a). Pervasive habitat disturbance, fragmentation, and loss of this species throughout the San Joaquin Valley have resulted from cultivation; habitat modification for petroleum and mineral extraction; pesticide applications; use of off-road vehicles; and construction for transportation, communication, and irrigation infrastructure (Stebbins 1954; Montanucci 1965; USFWS 1980, 1985a; Germano and Williams 1993). These activities present ongoing threats to the survival of blunt-nosed leopard lizards (USFWS 1998a).

A recovery plan for the blunt-nosed leopard lizard was prepared by USFWS in 1980 and revised in 1985 (USFWS 1985b) and 1998 (USFWS 1998a). Conservation efforts have included habitat and population surveys, studies of population demographics, habitat management, land acquisition, and development of management plans for public lands (USFWS 1998a). Current recovery efforts focus on three important factors: (1) determining appropriate habitat management and compatible land uses for blunt-nosed leopard lizards, (2) protecting additional habitat for the species in key locations of its range, and (3) determining more precisely how populations are affected by environmental variation (USFWS 1998a).

Giant Garter Snake

Giant garter snake, which is Federally listed as threatened, historically occurred throughout the Central Valley of California; however, the species' current range is confined to the Sacramento Valley, isolated sites in the San Joaquin Valley, and potentially in the Delta (Hansen and Brode 1980; Stebbins 2003; USFWS 1999c, 2006b). The giant garter snake inhabits sloughs, low-gradient streams, marshes, ponds, agricultural wetlands (e.g., rice fields), irrigation canals and drainage ditches, and adjacent uplands. Many of the populations of giant garter snake in the northern part of the range from Stockton (San Joaquin County) to Chico (Butte County) are relatively stable; however, the southernmost populations at the Mendota Wildlife Area (Fresno County) and the Grassland Wetlands (Merced County) are small, fragmented, unstable, and probably decreasing (USFWS 2006b). No sightings of giant garter snakes south of the

Mendota Wildlife Area, in the historically known range of the species, have occurred since the time of listing (Hansen 2002).This species has been observed at the San Luis, Kesterson, and West Bear Creek units of the San Luis NWR Complex and documented in the Mendota Wildlife Area (Dickert 2005) and south of the San Joaquin River in Fresno Slough (USFWS 2006b).

Giant garter snake is threatened primarily by habitat conversion, fragmentation, and degradation resulting from urban development (58 FR 54053–54065, October 20, 1993; Dickert 2005). The species is also threatened by incompatible agricultural practices, such as intensive vegetation control along canal banks and changes in crop composition. Giant garter snake species is susceptible to predation by native and nonnative species and affected by parasites and contaminants.

A draft recovery plan prepared for giant garter snake (USFWS 1999c, 2006b) is being updated and finalized. The Restoration Area is located in the San Joaquin Valley Recovery Unit, as described in the draft recovery plan for the species. Recovery plan recommendations for this area include developing and implementing a management plan benefiting giant garter snake, restoring wetland habitat for this species, and maintaining compatible agricultural practices.

Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo, which is a candidate species for Federal listing, breeds throughout much of North America and winters in South America (Hughes 1999). The California breeding range of western yellow-billed cuckoo is restricted to the Sacramento Valley, the South Fork of the Kern River, the lower Colorado River Valley, and sometimes the Prado Basin in Riverside and San Bernardino counties (Gaines and Laymon 1984). Most recent Sacramento Valley records are from the Sacramento River, from Todd Island in Tehama County south to Colusa State Park in Colusa County, and from the Feather River in Yuba and Sutter counties (Gaines and Laymon 1984). Yellow-billed cuckoo nest sites are associated with large and wide patches of riparian habitat (Laymon and Halterman 1989). In the western United States, yellow-billed cuckoos breed in broad, well-developed, low-elevation riparian woodlands composed primarily of mature cottonwoods (*Populus spp.*) and willows (*Salix spp.*). They have also been observed nesting in orchards adjacent to riparian habitats (Gaines and Laymon 1984). Typical nest sites in California have moderately high canopy closure and low total ground cover and are close to water (Laymon and Halterman 1987). In the late 1960s, a few yellow-billed cuckoos were observed regularly near the confluence of the Tuolumne and San Joaquin rivers, but this area was subsequently subject to intensive logging, and no cuckoos have been observed in recent years (Reeve, pers. comm., 1998, cited in McBain and Trush 2002). The yellow-billed cuckoo has been considered a rare migratory species in Stanislaus County during spring (Reeve 1988). This species has potential to nest in suitable habitat in the Restoration Area.

In California, yellow-billed cuckoo is threatened by the loss or degradation of suitable large tracts of riparian habitat, pesticide poisoning, and possibly reduced prey abundance resulting from widespread application of pesticides (Gaines and Laymon 1984). Conservation projects of the CVP have preserved habitat for yellow-billed cuckoo (DFG

2005). This species also has been included in habitat conservation and multispecies conservation planning efforts in southern California. These efforts have focused on conserving suitable breeding habitat by preserving and restoring large patches of riparian vegetation.

Least Bell's Vireo

Least Bell's vireo is Federally listed as endangered. This neotropical migrant species is found in California and other states in the southwestern and central western United States during the breeding season and during migration. The least Bell's vireo nests in dense, low, shrubby vegetation, generally early successional stages in riparian areas; it particularly favors cottonwood-willow forest but also nests in brushy fields, young second-growth forest or woodland, scrub oak, coastal chaparral, and mesquite brushlands, often near water in arid regions (Brown 1993). The vireo was formerly known to breed throughout the Sacramento and San Joaquin valleys, in the Sierra Nevada foothills, and in the Coast Ranges. It historically nested throughout riparian areas in the Central Valley and in other low-elevation riparian zones in California (Riparian Habitat Joint Venture (RHJV) 2004). The least Bell's vireo was characterized as abundant at one time; however, it was extirpated from the entire Central Valley by 1980 and is now absent from most of its historical range (RHJV 2004). Critical habitat for least Bell's vireo was designated in 1994 (59 FR 4845–4867, February 2, 1994). This critical habitat is located in southern California and does not include areas in the San Joaquin Valley. However, recent observations indicate that the species' range is expanding northward and that individuals are recolonizing areas that have been unoccupied for decades (RHJV 2004). Least Bell's vireos successfully nested at the San Joaquin River NWR in 2005 and 2006 (USFWS 2006c).

The primary threats to the least Bell's vireo are habitat loss and brood parasitism by the brown-headed cowbird (which is increased in areas with livestock) (RHJV 2004; USFWS 2006c). Threats also include habitat degradation caused by trampling of vegetation and nests by livestock and recreational activities, and habitat degradation resulting from the spread of invasive plants, particularly giant reed (*Arundo donax*).

USFWS has prepared a draft recovery plan for least Bell's vireo (USFWS 1998b). Least Bell's vireo is also addressed in most habitat conservation and multiple species planning efforts in southern California (DFG 2005), including the *Coachella Valley Multi-Species Habitat Conservation Plan*, *Western Riverside Multi-Species Habitat Conservation Plan*, *Camp Pendleton Resource Management Plan*, and *Orange County Natural Community Conservation Plan*. Recovery and management recommendations in these plans include continuing cowbird removal programs, monitoring nests for cowbird parasitism, and restoring riparian vegetation. Resolving land use conflicts, such as those related to livestock grazing in riparian corridors, water diversion, and developed parks adjacent to suitable vireo habitat, will require additional planning and management actions.

Fresno Kangaroo Rat

Fresno kangaroo rat, which is Federally listed as endangered, occupies only alkali desert scrub vegetation at elevations of 200 feet to 300 feet (DFG 1992b). This species, the smallest of California's kangaroo rats, historically occurred in north-central Merced

County, southwestern Madera County, and central Fresno County; however, it is believed to exist only in a small area in western Fresno County and is considered by some to be extirpated from along the San Joaquin River (McBain and Trush 2002). Fresno kangaroo rat was captured at the Alkali Sink Ecological Reserve and Mendota Wildlife Management Area near the Restoration Area in 1981, 1985, and 1992; however, extensive trapping since 1993 in Fresno and Madera counties has not documented additional kangaroo rats (McBain and Trush 2002). Critical habitat for this species has been established in and near the Mendota Wildlife Area, approximately 1.75 miles southeast of Reaches 2A and 2B (Figure 5-9). The primary threats affecting the Fresno kangaroo rat are habitat loss related to conversion to developed or agricultural land uses, and incompatible grazing practices, and potentially the illegal use of rodenticides (USFWS 1998a). Flooding of habitat by the San Joaquin River also has been considered a potential threat.

A recovery strategy for Fresno kangaroo rat has been developed by USFWS and was included in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). This strategy relies on additional preservation, restoration, and enhancement of habitat, and possibly reintroduction of Fresno kangaroo rats to restored but unoccupied habitat. Obtaining additional information on the distribution and abundance of Fresno kangaroo rats is also a component of the recovery strategy, as is developing management prescriptions for the species and continued monitoring of its abundance.

San Joaquin Valley (Riparian) Woodrat

San Joaquin Valley (or riparian) woodrat, which is Federally listed as endangered, was historically found along the San Joaquin, Stanislaus, and Tuolumne rivers and likely occurred throughout the riparian forests of the northern San Joaquin Valley (USFWS 1998a). This species' range has become much more restricted because of extensive modification and destruction of riparian habitat along streams in its former range in the Central Valley. The only verified extant population is restricted to approximately 250 acres of riparian forest in Caswell Memorial State Park on the Stanislaus River, at the confluence with the San Joaquin River (USFWS 1998a). San Joaquin Valley (riparian) woodrat is most abundant in areas with deciduous valley oaks, some live oaks and dense shrub cover. In riparian areas, the highest densities of woodrats and their houses are typically in willow thickets with an oak overstory. There are no documented CNDDB occurrences of San Joaquin Valley woodrat in or near the Restoration Area (CNDDB 2011), although it could occur in suitable habitat. Potential threats to this species include habitat conversion to agriculture, wildfire, disease, predation, flooding, drought, clearing of riparian vegetation, use of rodenticides, and browsing and trampling by ungulates (USFWS 1998a).

A recovery strategy for San Joaquin Valley woodrat has been developed by USFWS and was included in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). This strategy relies on additional preservation, restoration, and enhancement of habitat and possibly reintroduction of this woodrat to restored but unoccupied habitat. Reducing habitat fragmentation and conserving corridors of riparian habitat are important components of this strategy. Collaboration with landowners and levee maintenance districts is also a component of the recovery strategy.

Riparian Brush Rabbit

Riparian brush rabbit, which is Federally listed as endangered, inhabits riparian vegetation along the lower portions of the San Joaquin and Stanislaus rivers in the northern San Joaquin Valley. Although definitive information about this species' former distribution is lacking, the range of the riparian brush rabbit probably extended farther upstream than the Merced River, assuming that suitable habitat historically occurred along the length of the San Joaquin River system (Williams and Basey 1986). The riparian brush rabbit is restricted to several populations at Caswell Memorial State Park, near Manteca in San Joaquin County, along the Stanislaus River; along Paradise Cut, a channel of the San Joaquin River in the southern part of the Delta; and a recent reintroduction on private lands adjacent to the San Joaquin River NWR (Williams 1993; Williams and Basey 1986). A catastrophic flooding event in winter 1997 greatly reduced the number of riparian brush rabbits in Caswell Memorial State Park, spurring development of a captive breeding and reintroduction program. Habitat for the riparian brush rabbit consists of riparian forests with a dense understory shrub layer. Although suitable habitat is likely to be present in the Restoration Area, this species is not likely to occur there because of its limited distribution.

Potential threats to the riparian brush rabbit are habitat conversion to agriculture, wildfire, disease, predation, flooding, clearing of riparian vegetation, and the use of rodenticides. The species also is at risk from the lack of elevated mounds with protective cover to serve as flood refuges in remaining riparian habitat.

A draft recovery plan has been prepared for upland and riparian species in the San Joaquin Valley, including the riparian brush rabbit (USFWS 1998a). The recovery plan includes three actions: establish an emergency plan and monitoring system to provide swift action to save individuals and habitat at Caswell Memorial State Park in the event of flooding, wildfire, or a disease epidemic; develop and implement a cooperative program with landowners; and reevaluate the status of the rabbit within 3 years of recovery plan approval.

San Joaquin Kit Fox

San Joaquin kit fox is Federally listed as endangered. This species is presumed to have historically ranged from Contra Costa and San Joaquin counties in the north to Kern County in the south, and along the coast in Monterey, Santa Clara, and Santa Barbara counties. In portions of this geographic range, the San Joaquin kit fox still occurs in seasonal wetland, alkali desert scrub, grassland, and valley-foothill hardwood vegetation. Its optimum habitat consists of a variety of open, level areas with loose-textured soil, scattered shrubby vegetation, and little human disturbance. The San Joaquin kit fox has been observed in and adjacent to the West Bear Creek Unit of the San Luis NWR Complex (McBain and Trush 2002). Numerous additional records exist for this species in and adjacent to the Restoration Area, including records of active dens. Although most of these records are more than 15 years old (CNDDB 2011), this species is likely to be present in suitable habitat in the Restoration Area.

Loss and degradation of habitat by agricultural, industrial, and urban development and associated practices continue, decreasing the carrying capacity of remaining habitat and threatening kit fox survival (USFWS 2007). Such losses contribute to a decline in the number of kit foxes by displacing foxes, causing direct and indirect mortalities, introducing barriers to movement, and reducing prey populations. San Joaquin kit fox is also threatened by rodenticide use and by competitive displacement or predation by other species, such as the nonnative red fox (*Vulpes vulpes*), coyote (*Canis latrans*), domestic dog (*C. familiaris*), bobcat (*Felis rufus*), and large raptors.

A recovery strategy for San Joaquin kit fox has been developed by USFWS and was included in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a), with recovery units that include portions of the Action Area (Figure 5-3). This strategy relies on enhanced preservation and management of three core populations, and an important component of this preservation and management is sustaining and increasing habitat connectivity. Gathering additional information on the distribution and movement of kit foxes is also a component of the recovery strategy, along with developing restoration and management prescriptions for the species.

Chapter 6.0
Effects

Implementing the Proposed Action may affect Federally listed and proposed species, designated and proposed critical habitat, and EFH in the following areas:

- San Joaquin River upstream from Friant Dam, including Millerton Lake, to Kerckhoff Dam.
- San Joaquin River from Friant Dam to the Merced River confluence (Restoration Area), including Reaches 1 through 5 and portions of the flood management system, and extending approximately 4,000 feet outward along either side of San Joaquin River and the bypasses.
- San Joaquin River from the Merced River to the Delta, including tributaries.
- South Delta, which is defined as the San Joaquin River within the Delta west to its confluence with the Sacramento River.

This chapter presents an analysis of the direct, indirect and cumulative effects that would result from implementing the Proposed Action (see Chapter 3.0, "Description of the Proposed Action"). This analysis includes the effects of both project- and program-level actions. Other activities that are interrelated or interdependent with the Proposed Action were considered for their potential to affect listed species.

In addition to analyzing the potential effects on species and their habitats, this chapter describes the effects of the Proposed Action on designated critical habitat and EFH. USFWS and NMFS (1998) define an adverse effect as it applies to critical habitat as follows:

> *…a direct or indirect alteration that appreciably diminishes the value of critical habitat for both the survival and recovery of a listed species. Such alterations include, but are not limited to, alterations adversely modifying any of those physical or biological features that were the basis for determining the habitat to be critical.*

6.1 Direct and Indirect Effects

The Proposed Action could directly or indirectly cause both adverse and beneficial effects on Federally listed and proposed species and designated and proposed critical habitat. Project-level effects could occur under the Proposed Action throughout the Action Area. Program-level effects could occur under the Proposed Action along the San

Joaquin River from Friant Dam to the Delta. Conservation measures to avoid, minimize, or compensate for potentially adverse effects are included in the Proposed Action (Table 3-4) and would be implemented with the project- and program-level actions, where applicable. These measures would enhance riparian and emergent wetland communities by controlling invasive species that can displace native riparian and wetland species. The potential effects of the Proposed Action to special-status fish, EFH, special-status plants, and wildlife are analyzed in the following sections.

6.1.1 Special-Status Fish

Direct and indirect effects of the Proposed Action on special-status fish, including Central Valley steelhead, Sacramento River winter-run Chinook salmon, and Central Valley spring-run and fall-run Chinook salmon (for EFH), southern DPS of the North American green sturgeon, and delta smelt are described below. Flow data used in the analyses are provided in Appendix H, "Modeling," of the Draft PEIS/R (Reclamation and DWR 2011). Additionally, sensitivity analyses were completed to evaluate the range of potential effects on special-status fish under the 2008 USFWS CVP/SWP Operations BO (USFWS 2008) and 2009 NMFS CVP/SWP Operations BO (NMFS 2009a) reasonable and prudent alternatives (RPA). These analyses are presented in Appendix B.

Central Valley Steelhead DPS

Within the Action Area, the geographic range and designated critical habitat of Central Valley steelhead includes the south Delta and the San Joaquin River and its tributaries from the Merced River to the Delta. However, after implementation of the Settlement, Central Valley steelhead are expected to occupy the San Joaquin River up to Friant Dam. Overall, the Proposed Action is not likely to adversely affect Central Valley steelhead or its designated critical habitat.

Effects of Project-Level Actions. The potential project-level effects to steelhead and its designated critical habitat are described below for the San Joaquin River and its tributaries (Merced, Tuolumne and Stanislaus rivers) and the south Delta.

San Joaquin River and Tributaries. Implementing Interim and Restoration flows would increase flows in the San Joaquin River from Friant Dam to the Delta. Segments of the San Joaquin River upstream from the Merced River were often dry until the implementation of Interim Flows, initiated in WY 2010. The continued release of Interim Flows, and ultimately of Restoration Flows, has the potential to lead towards a new population of steelhead in Restoration Area. If established, this population could help increase the stability of the DPS. Program-level actions in the Restoration Area would further improve habitat conditions for steelhead attempting to reestablish in the San Joaquin River. Increased flows in the San Joaquin River downstream from the Merced River confluence would improve overall conditions for migrating adult and juvenile steelhead by improving water quality, and providing slightly higher water velocities in the San Joaquin River, reducing or eliminating migration delays by both adults and juveniles. Implementing Interim and Restoration flows is expected to have no effect on water temperatures in the San Joaquin River downstream from the Merced River confluence. Because flows on the lower San Joaquin River and its tributaries would be managed to meet specific instream requirements, and would also be managed by Water

Operations Management Team (WOMT), implementing Interim and Restoration flows would not result in adverse effects to steelhead.

Flow Patterns. The Vernalis water quality requirement is based on an electrical conductivity (EC) requirement of 700 and 1000 micromhos/centimeter for the irrigation (April to August) and non-irrigation (September to March) seasons, respectively. This is modeled in CalSim by estimating the water quality at Vernalis using a link-node salinity algorithm, consisting of a series of EC mass balance equations, covering the San Joaquin River from Lander Avenue to Vernalis. The computed EC from an upstream node is used as the input EC of a downstream node. Flow-EC regressions are used for the San Joaquin River at Lander Avenue, Merced River near Stevinson, and the Tuolumne River near Modesto. Mud and Salt sloughs, both return flow and accretion EC, use monthly average values. If the estimated EC does not meet the standard at Vernalis, higher quality releases are made from New Melones Reservoir on the Stanislaus River to mix with the San Joaquin River to meet the standard.

NMFS Operations BO and RPAs addressing San Joaquin and Stanislaus river effects on steelhead establish conditions that include those contained in VAMP, exclusive of requirements to meet Vernalis flows, per D-1641, with releases from the Merced and Tuolumne rivers. Per Appendix 5 of the NMFS BO, the following RPA specifies actions to be taken to accommodate uncertainties regarding the status of VAMP experiments beginning in 2012:

Phase II: *From April 1 through May 31:*

1. *Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action III.1.3 and Appendix 2-E.*

2. *Reclamation and DWR shall implement the Vernalis flow-to-combined export ratios in the following table, based on a 14-day running average:*

San Joaquin Valley Classification	***Vernalis flow (cfs): CVP/SWP combined export ratio***
Critically dry	*1:1*
Dry	*2:1*
Below normal	*3:1*
Above normal	*4:1*
Wet	*4:1*
Vernalis flow equal or greater than 21,750 cfs	*Unrestricted exports until flood recedes below 21,750 cfs*

Exception procedure for multiple dry years: If the previous 2 years plus current year of San Joaquin Valley "60-20-20" Water Year Hydrologic Classification and Indicator as defined in D-1641 and provided in the following table, is 6 or less, AND the New Melones Index is less than 1 MAF, export shall be limited to a 1:1 ratio with San Joaquin River inflow, as measured at Vernalis:

San Joaquin Valley Classification	***Indicator***
Critically dry	*1*
Dry	*2*
Below normal	*3*
Above normal	*4*
Wet	*5*

Although the 2009 NMFS BO and RPAs state that agreements for VAMP-like conditions will be pursued, the future of VAMP is uncertain, and Reclamation and San Joaquin River Authority participants are discussing the future approach for VAMP. No decisions on the future of VAMP have been made at the time of preparation of this BA. However, because of the requirements in the NMFS BO, it is reasonable to assume that VAMP or a VAMP-like action would occur in the future.

The Proposed Action would have the potential to indirectly changes flows on tributaries to the San Joaquin River in response to existing regulatory and operational requirements. Interim and Restoration flows would be subject to the existing regulatory and operational requirements of the water supply system. VAMP-like flow requirements at Vernalis and the Vernalis water quality standard are the predominant factors controlling operations on the tributaries in response to flows in the mainstem San Joaquin River, as follows:

- **Vernalis Water Quality Standard –** Interim or Restoration flows would improve water quality conditions in the San Joaquin River upstream from the Stanislaus River, thereby reducing required releases from New Melones Reservoir on the Stanislaus River pursuant to SWRCB Water Right Decision 1641 (D-1641) to achieve the Vernalis water quality standard. The Merced and Tuolumne rivers are not required to make releases to meet the Vernalis water quality standard.

- **VAMP Flow Requirements –** Interim and Restoration flows may contribute to VAMP flow requirements at Vernalis in the mainstem San Joaquin River, indirectly reducing tributary releases required for VAMP in late April and early May. These reduced release requirements in April and May could result in higher tributary reservoir storage, which would affect local operations on the tributaries at a later time in the year. Tributary releases to meet VAMP flow requirements at Vernalis could be affected in one of two ways, as follows:

  - When Interim and Restoration flows contribute to meeting the same VAMP flow requirements at Vernalis that would have been in place under baseline conditions, required releases from tributary reservoirs could be reduced.

  - When Interim and Restoration flows would cause higher VAMP flow requirements at Vernalis than would have been in place under baseline conditions, releases from tributary reservoirs would be required to meet the VAMP flow requirements at Vernalis.

Although Interim and Restoration flows could reduce required tributary releases to meet VAMP flow requirements at Vernalis and the Vernalis water quality standard, reservoir releases on the Merced, Tuolumne, and Stanislaus rivers are also controlled by tributary-specific operational requirements, including flood management and water supply requirements. The Stanislaus Operations Group (SOG) was established as a tool to fulfill implementation of the RPAs for the CVP/SWP long-term operations BOs. This group makes recommendations based on water flow and temperature, and provides NMFS and Reclamation with advice and recommendations from other agencies. The SOG has the ability to determine whether additional flow needs to be released from New Melones Dam to meet the Vernalis water quality standard; this group also works with the WOMT to meet fisheries needs in the Stanislaus River.

Under the Proposed Action, flows on the tributaries almost always either meet the target flows (Table 6-1) or, if not, then do not change from baseline conditions.

Flows on the tributaries would meet the target flows for steelhead (data provided in Appendix B), as follows:

- Merced River – In April of above-normal water years (San Joaquin Valley 60-20-20 Index), Merced River flows under the Proposed Action are lower than under baseline conditions. Decreases in required releases on the Merced River could occur in April of above normal water years, and could allow refilling of Lake McClure and Lake McSwain, which would provide cooler water for release later in the year than would otherwise be available. Therefore, the Proposed Action is not likely to adversely affect Central Valley steelhead in the Merced River.

- Tuolumne River – Flows in the Tuolumne River would meet target flows under the Proposed Action. Therefore, there would be no affect to Central Valley steelhead resulting from the Proposed Action in the Tuolumne River.

- Stanislaus River – Under baseline conditions and the Proposed Action, simulated flows on the Stanislaus River in March of critical, dry and below normal water years (San Joaquin Valley 60-20-20 Index) do not always meet the flow standard set for migrating Chinook salmon and steelhead (2,000 cfs). Therefore, it is reasonable to anticipate that under the Proposed Action, flows would be released from New Melones Dam to benefit or minimize effects to Stanislaus River steelhead. Additionally, WOMT would manage the flows to provide flows needed to protect steelhead outmigration in years where VAMP flow requirements at Vernalis and the Vernalis water quality standard would otherwise result in reduced flows in the Stanislaus River. Therefore, the Proposed Action is not likely to adversely affect Central Valley steelhead in the Stanislaus River.

Table 6-1.
Tributary Flows Assumed to Provide Maximum Habitat

Time Frame	Life Stage	Flow (cfs)
Merced River Chinook Salmon/Steehead[1]		
October 1 – December 31	Spawning	400
January 1 – March 15	Incubation/fry rearing	400
March 16 – June 15	Juvenile Rearing/Migration	1,500
June 15 – October 31	Juvenile rearing/Adult (steelhead)	250
Tuolumne River Chinook Salmon[2]		
October 1 – April 30	Spawning/Incubation/Fry Rearing	275
February 1 – October 31	Juvenile Rearing	150
January 1 – June 30	Juvenile Migration	1,100
Tuolumne River Steelhead[2]		
January 1 – December 31	All life stages	275
March 15 – June 30	Juvenile Migration	1,100
Stanislaus River Chinook Salmon[3]		
October 15 – December 31	Spawning	300
January 1 – February 28	Incubation/Fry Rearing	300
February 15 – March 15	Juvenile Rearing	200
March 15 – June 30	Juvenile Migration	2,000
Stanislaus River Steelhead[3]		
November 1 – Feb 28	Spawning	200
January 1 – March 31	Incubation/Fry Rearing	200
January 1 – December 31	Juvenile Rearing	150
March 15 – June 30	Juvenile Migration	2,000

Sources: USFWS 1993, 1995, and 1997, DFG 2005, NMFS 2009
Notes:
[1] Because information is limited on steelhead, flows needed for Chinook salmon and steelhead are combined.
[2] Flows are based on USFWS 1995 and from results of the California Department of Fish and Game Chinook model.
[3] Flows are based on USFWS 1993, and from the 2009 Operations Criteria and Plan Biological Opinion for below-normal year
Key:
cfs = cubic feet per second

As described above, the Proposed Action would result in an overall increase in habitat quality and quantity (due to changes in connectivity to downstream reaches, geomorphic changes in Restoration Area, and changes in tributary flows). This increase in habitat quality and availability would lead to increased steelhead abundance and survival. Therefore the Proposed Action is not likely to adversely affect, but is likely to provide an overall benefit to Central Valley steelhead.

Habitat Modification. Interim and Restoration flows are expected to increase the quality and quantity of aquatic and riparian habitat and improve channel morphology and benefit steelhead once steelhead are able to access and establish in the Restoration Area. Habitat quality and quantity are largely affected by connectivity to downstream reaches, geomorphic changes in Restoration Area, and changes in tributary flows. This increase in habitat quantity and quality would lead to increased steelhead abundance and survival. While DFG has conducted a meso-habitat survey, only quantifications of habitat types (e.g., pool, riffle, run) were presented, but the quality of these habitat units was not discussed. Therefore, a description of the current habitat suitability for steelhead is not available.

Year-round continuous baseflow in the San Joaquin River under the Proposed Action would provide river flow connectivity between the Restoration Area and the section below the Merced River confluence, and remove some barriers that restrict fish movement, thus increasing available habitat in all reaches of the Restoration Area. Increased flows upstream from the Merced River confluence may potentially trigger adult Central Valley steelhead migrating toward the Merced River to continue into the San Joaquin River upstream to the Restoration Area, and would improve access to habitat, particularly restored floodplain habitats. Such straying would temporarily reduce the Merced River steelhead population, but would contribute to establishing a new population into the San Joaquin River. If established, this population could help increase the stability of the DPS. Program-level actions in the Restoration Area would further improve habitat conditions for steelhead attempting to reestablish in the San Joaquin River.

Interim and Restoration flows would increase flow in the San Joaquin River throughout the year during most water year types, and would increase in-channel and floodplain habitat quantity and availability primarily through geomorphic changes. Interim and Restoration flows in Dry through Wet years (based on Restoration water year types) are expected to result in perennial flow throughout the Restoration Area. Perennial streamflow would improve instream and riparian habitat conditions for steelhead from Friant Dam to the Merced River during all but Critical-Low years. Along with other factors, increased flow would likely increase the quantity and quality of floodplain habitat, riparian habitat, and in-channel aquatic habitat in all reaches of the Restoration Area, although this increase has not yet been quantified. In years when flow would not result in full connectivity, operations and maintenance of Hills Ferry Barrier would continue until sufficient habitat and channel improvements to support salmonids are complete.

NMFS permits the take of Federally listed threatened species for rescue and salvage by various State and nongovernmental agencies through the ESA Section 10a(1)A and 4(d) rules. In the unlikely event that ESA-listed anadromous fish, including Central Valley steelhead, stray into San Joaquin River reaches upstream from the Merced River confluence, these fish could be salvaged under these authorities. Additionally, DFG applies annually for an ESA Section 4(d) research permit and accompanying take limit for Central Valley steelhead from NMFS for operation of the Hills Ferry Barrier. In October 2011, DFG submitted an application for a new permit covering actions for the 2012 operation of Hills Ferry Barrier to NMFS for review. If Central Valley steelhead are encountered at or above the Hills Ferry Barrier during 2012 Interim Flows, the Central Valley steelhead would be captured and released downstream in suitable reaches, as would be required by the permit. Salvaged fish will likely have genetic samples (i.e., fin clips) taken. Such recovery would be conducted under and consistent with DFG's ESA Section 4(d) research permit.

Implementation of the Steelhead Monitoring Plan, as described in the Proposed Action, could reduce effects to steelhead should they occur upstream despite operation of Hills Ferry Barrier. Reclamation will coordinate with the appropriate agencies to implement this plan and report results. The Steelhead Monitoring Plan calls for the implementation of up to three options to monitor for steelhead that could make it past Hills Ferry Barrier. The first option calls for the utilization of electrofishing at partial barriers and false upstream migration pathways including Mud Slough, Salt Slough, Newman Wasteway, and drop structures at the mouth of the Eastside Bypass, Mariposa Bypass, and Sand Slough Control Structure. The second option would include the use of large fyke trap(s) above the Merced River confluence and below false attraction and entrainment points. The third option would involve the use of weirs, with or without traps at false attraction locations and existing structures to detect, trap, and relocate Central Valley steelhead. The three options may be used singularly or in combination, depending on physical river conditions and in coordination with NMFS and the SJRRP FMWG. All captured Central Valley steelhead will be tagged and transported downstream of the Merced River confluence in transport tanks. In the event a steelhead is encountered in the Restoration Area, NMFS will be notified immediately.

In the absence of a monitoring plan and management plan, the impacts to Central Valley steelhead may result in potential undocumented straying during the time when steelhead would be migrating. However, because of measures adopted to prevent straying of Merced River adult steelhead into the San Joaquin River upstream from the confluence, implementing the Interim and Restoration Flows would not result in adverse effects to Central Valley steelhead.

At flows of 2,200 cfs or more, appreciable bed scour and sediment transport may occur in the sand-bedded portions of the channel in the Restoration Area (McBain and Trush 2002). Under Restoration Flows, it is likely that seasonal sediment-transporting flows would occur relatively frequently in Reach 1, and in turn initiate a sustained sequence of channel-forming processes that maintain both aquatic and riparian habitat. Sediment transport in Reaches 2 through 5 would likely be continuous under the Proposed Action, because sand-bedded rivers typically remain in a state of constant sediment transport (McBain and Trush 2002). However, in Reach 2B, vegetation that has established in the channel would likely limit the capacity of flow to transport sediment because of increased roughness. The magnitude of Interim and Restoration flows would likely be too low to appreciably scour any riparian vegetation that was established in the channel bed in Reach 2B or any other reaches in the Restoration Area. Overall, under the Proposed Action, seasonal sediment transport represents a more normative condition compared to baseline conditions. As a result, mature riparian vegetation would establish, habitat heterogeneity would increase, and connectivity between habitats preferable to steelhead would most likely increase. Recovery and reestablishment of riparian vegetation, especially large trees, is expected to occur as a direct result of geomorphic processes established because of Restoration Flows, and, in turn, would benefit Central Valley steelhead.

The initial transport of fine sediment stored in the bed and banks of Reach 1 during Interim Flows could have short-term effects on sediment transport capacity and channel form that in turn may affect habitat for representative fish species. The effects would be most pronounced in Reach 2A, where transported fine sediment would be most likely to eventually be deposited and result in channel form changes. Initially, there would be a period of transient adjustment in channel form and consequent aquatic and riparian habitat that would slow over time to a more stable condition.

Restoration Flows would reestablish regular transport and routing of coarse sediment (particles greater than 4 millimeters (mm) in diameter) stored in the bed and banks of the San Joaquin River below Friant Dam. The construction of Friant Dam has cut off the majority of the coarse sediment supply, which would otherwise originate from upstream. However, the increase in flows, with the exception of the Spring Rise and Pulse flows, is not expected to result in transport of materials beyond the current amount. Under Spring Pulse flows of up to 8,000 cfs, sediment transport would likely occur in Reach 1 (Stillwater Sciences 2003, Kondolf 2005). The Spring Pulse flows are intended to improve habitat conditions for salmonids and other native fishes through various factors, which include providing flows sufficient to initiate fluvial geomorphic processes (i.e., mobilizing and flushing spawning gravels in wetter years), and providing flows sufficient for riparian seedbed preparation, seeding establishment, and prevention of vegetation encroachment in wetter years.

Several historical and recent estimates of salmonid spawning gravel quantity have been made in the Restoration Area (Table 6-2). In 1943, an estimate was made of 1,000,000 square feet of suitable spawning gravel at a flow of 350 cfs in the section between Gravelly Ford and Friant Dam (38 miles of channel) (Fry and Hughes 1958, as cited in Cain 1997). In 1957, Ehlers (R. Ehlers, pers. comm. with J. Cain, as cited in Cain 1997) estimated that over twice as much (2,600,000 square feet) spawning gravel occurred in the same reach, only 70 percent of which (1,820,000 square feet) was suitable for spawning (Table 6-2). By the late 1950s, DFG was concerned that heavy silt and sand deposited by gravel mining operations was damaging the last of the available suitable spawning habitat, which at that time DFG believed was confined to the 13 miles below Friant Dam (Reach 1 upstream from Highway 41).

Table 6-2.
Summary of Anadromous Salmonid Spawning Habitat Estimates in Reach 1 of the Restoration Area

Source	Survey Year	Extent of Survey	Estimated Total (square feet)	Estimated Suitable (square feet)
Clark (1942)	1942	Highway 41 (RM 255.2) to Kerckhoff Powerhouse (281.5)	417,000	266,800[1]
Fry and Hughes (1958)	1943	Gravelly Ford (RM 229) to Friant Dam (267.5)	1,000,000[2]	None
Ehlers, pers. comm., in Cain (1997)	1957	Gravelly Ford (RM 229) to Friant Dam (267.5)	2,600,000	1,820,000[3]
Cain (1997)	1996	Gravelly Ford (RM 229) to Friant Dam (267.5)	303,000	none
Jones and Stokes Assoc./Entrix (in McBain and Trush 2002)	2001	Friant Dam to Skaggs Bridge	773,000[4]	408,000[4, 5]
Stillwater Sciences, (in McBain and Trush 2002)	2002	Friant Dam to Highway 99 Bridge	357,000[6]	281,400[1, 6]

Notes:
[1] spawning habitat between Highway 41 and Friant Dam (RM 267.5)
[2] estimated at 350 cfs; therefore, incorporated hydraulic suitability
[3] 70 percent of 2,600,000 square feet was suitable; presumed criterion was quality (limit of fine sediment in gravel)
[4] included gravel beyond the baseflow channel (e.g., on point bars, etc.), probable over-estimate
[5] based on portion of spawning gravel with less than 40 percent fines (ocular estimate)
[6] incorporated hydraulic suitability at potential spawning baseflows
Key:
RM = river mile

More recently, Cain (1997) estimated a total of 303,000 square feet of spawning gravel between Gravelly Ford and Friant Dam (Table 6-2). Most riffles in Reach 1 were described as having suitable gravels, and Cain (1997) attributed the decline of spawning gravel in Reach 1 to effects of Friant Dam, gravel mining operations, and riparian vegetation encroachment. In summer and fall 2000, surveys were conducted of potential spawning gravel in the upper San Joaquin River. Areas considered suitable were delineated, recorded on aerial photos, and transferred to a geographic information system (GIS). These surveys estimated 773,000 square feet of spawning habitat for salmon and steelhead available between Friant Dam (RM 267) and Skaggs Bridge (RM 234), of which 408,000 square feet contained less than 40 percent fines based on ocular estimates (Table 6-2).

In spring 2002, a second survey was conducted to map suitable spawning gravel from the RM 267 (Friant Dam) to RM 243 (Highway 99). Spawning habitat suitability was based on the depth, velocity, and substrate requirements for Chinook salmon and steelhead (McBain and Trush 2002). Thirty-nine riffles were observed in the 12 miles of river between Highway 41 and Friant Dam, and an additional 26 riffles were observed in the 12 miles of river between Highway 99 and Highway 41. Many riffles were composed of two or more subpatches, often varying in substrate quality and hydraulic suitability. More than 357,000 square feet of suitable spawning gravel was delineated between Highway

99 Bridge and Friant Dam, of which approximately 281,400 square feet of suitable spawning gravel occurred between Highway 41 and Friant Dam (Table 6-2). Riffles were infrequent and typically small, with an average area of 5,500 square feet. Many riffles were adjacent to suitable rearing habitat, particularly upstream from Highway 41, but very few riffles were adjacent to suitable holding habitat. Substrate was generally well-rounded, with low embeddedness, and low fines. A high proportion of coarse sand (greater than 0.08 inches) appeared to occur upstream from Highway 41, and a higher proportion of fine sand (less than 0.08 inches) downstream from Highway 41 (McBain and Trush 2002).

Between Friant Dam and Highway 41 (12 miles of channel), historical estimates of spawning gravel quantity of 266,800 square feet (Clark 1942) are similar to the most recent estimates of 281,400 square feet (based on 2002 surveys, and assuming use of similar suitability criteria). Examining Reach 1 (38 miles of channel), historical estimates of 1,000,000 square feet and 1,820,000 square feet (Ehlers, pers. comm., Fry and Hughes 1958, both as cited in Cain 1997) are significantly greater than recent estimates of 303,000 square feet (Cain 1997). The various spawning gravel surveys are somewhat difficult to compare because of differing (or unknown) suitability criteria and methods; therefore, a conclusion cannot be confidently made regarding the degree of spawning habitat loss. An assessment by McBain and Trush (2002), based on review of historical photographs and other evidence, indicates that significant loss of suitable spawning habitat has occurred.

In addition to altering spawning gravel dynamics, the presence of Friant Dam likely has changed sedimentation rates in areas outside the main river channel, such as floodplains and side channels. Reduced frequencies of overbank flow, combined with reduced suspended sediment concentrations, may serve to extend the life span of off-channel habitats. The extent to which this is offset by any increase in sediment loading from agricultural runoff is difficult to determine because of a lack of data. Reduced sediment loading may have had particularly significant effects on oxbow lakes, which are disconnected from the mainstem and thus may only aggrade (fill in) during the largest, most infrequent overbank flow events. Reduced bedload under post-dam conditions may be less likely to generate closed off-channel habitat areas (oxbow lakes and sloughs). In addition to locally affecting meander migration rates, gravel bar dynamics also can regulate the connectivity of off-channel habitat to the mainstem, and thus alter its quality for fish and other aquatic species.

Water Temperature. Water temperature reductions would benefit steelhead once they were able to access and establish a population in the San Joaquin River upstream from the Merced River confluence. Based on SJR5Q model results, spring and early summer (May and June) water temperatures (for all water year types) in Reach 1 would be approximately 5°F lower under the Proposed Action than under baseline conditions. In the wetted portions of Reaches 2 and 3, spring and early summer (May and June) water temperatures would be 3°F to 5°F lower than baseline conditions, with little to no expected differences in water temperatures during the warmest months (July and August). Midwinter (December and January) water temperatures in Reaches 2 and 3 would be approximately 3°F lower under the Proposed Action than under baseline conditions.

Water temperatures in Reaches 4 and 5 would be 1°F to 2°F lower than baseline conditions during spring and early summer and similar to baseline conditions during other seasons (see Appendix H, "Modeling," of the Draft PEIS/R; Reclamation and DWR 2011).

The Interim Flows monitoring program included monitoring water temperatures throughout the Restoration Area (Reclamation 2011a). In one year of sampling, water temperatures in Reach 1A tended to remain below 60°F until Balls Ranch Bridge. Downstream from that, holding pools and river channel typically exceeded 60F in summer months, and river temperatures sometimes approached 75°F. Some gravel pits recorded water temperatures up to 90°F, but most were 80°F and below. Reach 1B and downstream all had substantially fewer monitoring stations. Reaches 1B, 2 and 4 registered water temperatures as warm as 85°F, while water temperatures in Reach 3 were below 80°F (with only a single monitoring station).

Based on information developed from the FMP, Table 6-3 shows the water temperature objectives for Chinook salmon. Based on these criteria, only Reach 1A currently provides optimal water temperature conditions for Chinook salmon.

Water Quality. Interim and Restoration flows could dilute the concentration of agricultural discharges of pollutants, suspended sediments, and turbidity currently found in the San Joaquin River from Friant Dam to the Merced River, and could mobilize pollutants in sediments of Reach 4B1. The additional water is not expected, however, to reduce pollutants to levels that significantly improve conditions for steelhead once they can access and inhabit the Restoration Area. Continued discharges and nonpoint source runoff of agricultural pollutants may affect Central Valley steelhead once they are able to access the San Joaquin River upstream from the Merced River confluence.

Pollutants from agricultural runoff currently found in the river include mineral contaminants (e.g., arsenic, boron), mercury, and pesticides (e.g., chlorpyrifos, DDT, diazinon, Group A pesticides). Model results for EC, which is used as a surrogate for water quality, indicate little to no difference in EC between baseline conditions and the Proposed Action across all water year types for Reaches 1, 2, and 4, while EC in Reaches 3 and 5 would decrease as a result of the Proposed Action from October through April (see Appendix H, "Modeling" in the Draft PEIS/R; Reclamation and DWR 2011). The dilution effect of Interim and Restoration flows would improve water quality but not to a level that would be expected to significantly improve conditions for steelhead.

Continued discharges and nonpoint source runoff of suspended sediments may affect steelhead migrating through Reaches 3 through 5. Interim and Restoration flows are expected to dilute the concentration of suspended sediment and turbidity from agricultural runoff currently found in the river between Friant Dam and the Merced River. While this dilution would be beneficial, it is not expected to reduce suspended sediment or turbidity to a level that would significantly improve conditions for steelhead.

Table 6-3.
Water Temperature Objectives for the Restoration of Central Valley Chinook Salmon

Spring-Run and Fall-Run Chinook Salmon												
Life Stage	**Jan**	**Feb**	**Mar**	**Apr**	**May**	**June**	**Jul**	**Aug**	**Sep**	**Oct**	**Nov**	**Dec**
Adult Migration			Optimal: ≤ 59°F (15°C) Critical: 62.6 – 68°F (17 – 20°C) Lethal: >68°F (20°C)									
Adult Holding (Spring-Run Only)				Optimal: ≤55°F (13°C) Critical: 62.6 – 68°F (17 – 20°C) Lethal: >68°F (20°C)								
Spawning								Optimal: ≤ 57°F (13.9°C) Critical: 60 – 62.6°F (15.5 – 17°C) Lethal: 62.6°F or greater (17°C)				
Incubation and Emergence								Optimal: ≤55°F (13°C) Critical: 58 – 60°F (14.4 – 15.6°C) Lethal: >60°F (15.6°C)				
In-River Fry/Juvenile	Optimal: ≤60°F (15.6°C), young of year rearing; ≤62.6°F (18°C), late season rearing (primarily spring-run) Critical: 64.4 – 70°F (18-21.1°C) Lethal: >75 °F (23.9°C), prolonged exposure											
Floodplain Rearing*	Optimal: 55 – 68°F (13 – 20°C), unlimited food supply											
Outmigration	Optimal: ≤60°F (15.6°C) Critical: 64.4 – 70°F (18 – 21.1°C) Lethal: >75°F (23.9°C), prolonged exposure											

Sources: EPA 2003, Rich 2007, Pagliughi 2008, Gordus 2009.

Note:

* Floodplain rearing temperatures represent growth maximizing temperatures based on floodplain condition. No critical or lethal temperatures are cited assuming fish have volitional access and egress from floodplain habitat to avoid unsuitable conditions.

Shaded box indicates life stage is present

Key:
°F = degrees Fahrenheit
°C = degrees Celsius

Because flood flows already frequently move through all reaches of the San Joaquin River and bypasses other than Reach 4B1, Interim and Restoration flows are not anticipated to degrade water quality by mobilizing pollutants in these reaches. However, constituents may have accumulated in sediments in segments of Reach 4B that typically experience little or no flow, including pollutants associated with agricultural practices in the region, and therefore short-term surface water quality degradation could occur under the Proposed Action because pollutants would be flushed from sediments within the river channel. This mobilization would be a short-term effect, and would not be anticipated to cause an adverse effect to Central Valley steelhead.

Interim and Restoration flows could be recaptured at the East Bear Creek Unit of the San Luis NWR. The San Luis NWR is known to contain high deposits of selenium and salts from agricultural drainage flows that were captured there in the early 1970s. Return flows to the San Joaquin River from the East Bear Creek Unit may contain pollutants that can harm fish. Under the Proposed Action, the East Bear Creek Unit could receive delivery of Interim and Restoration flows in lieu of existing CVP supplies. However, these deliveries would not increase the quantity of return flows and thus would not be anticipated to mobilize pollutants in this area. Therefore the delivery of Interim and Restoration flows to the East Bear Creek Unit would not change the quality of return flows to the San Joaquin River.

Interim Flows water quality monitoring, while providing only a limited dataset, has shown high concentrations of bifenthrin, lambda-cyhalothrin and dissolved copper. Bifenthrin occurs in the sediment, and can cause reduced prey availability, stress behaviors, or mortality. Lambda-cyhalothrin is found to be harmful to aquatic invertebrates, again, affecting prey availability. Dissolved copper can result in reduced prey availability, impaired olfaction, interference with migration, depressed immune response, and interference with brain function. Based on the water quality data collected to date, few constituents are present at concentrations that exceed aquatic life thresholds (Reclamation 2011). However, other water quality studies conducted on the San Joaquin River have found elevated levels of constituents, such as selenium and methyl-mercury, in the system that may pose threats to aquatic organisms (Reclamation 2011a). It is unknown whether Interim or Restoration flows will result in an increase in selenium or methyl-mercury until further monitoring results are provided.

Changes in water quality as a result of Interim and Restoration flows may potentially adversely affect steelhead if concentrations of bifenthrin, lambda-cyhalothrin and dissolved copper are not reduced.

Disease. Implementing Interim and Restoration flows would provide access by Central Valley steelhead to all reaches of the San Joaquin River from Friant Dam to the Merced River. The restoration of connectivity between steelhead and resident/hatchery reared rainbow trout in the San Joaquin River near Friant Dam has the potential to increase the risk of disease transmission, which could result in mortality or reduced fitness of Central Valley steelhead. Rainbow trout from the Stanislaus River have been previously detected with Myxobolus cerebralis (Modin 1998). Myxobolus cerebralis is a parasite that causes whirling disease in salmonids which is transmitted by the oligochaete host Tubifex tubifex (Wagner 2002). The Tubifex worm has been identified as the only known host of M. cerebralis; other genera of oligochaetes have been tested, but did not produce infectivity for whirling disease (Markiw and Wolf 1983, Wolf et al. 1986.). Noteworthy is an aquatic worm harvesting operation at San Joaquin Fish Hatchery. The aquatic worms feed on the solid waste from the hatchery's effluent. DFG conducted preliminary investigations on the species composition at the site in 2009. Findings indicated that the dominant Oligochaete harvested at the site is from the Family Lumbriculidae, though a small percentage of tubifex worms were observed (P. Adelizi pers. com.).

Although *M. cerebralis* is present in several watersheds in California, no adverse effects on salmon or trout populations have been observed in California (Modin 1998). In general rainbow trout are more susceptible to the disease than steelhead (O'Grodnick 1979, Hoffman 1990). Furthermore, susceptibility to infection varies among stocks and individual fish (Markiw 1992). Therefore, the increased risk of the disease transmission is low and not likely to adversely affect Central Valley steelhead.

South Delta. Increased San Joaquin River inflow is likely to improve conditions for emigrating steelhead; however, increased flows in the upper Old and Middle rivers resulting from higher levels of pumping in response to increased San Joaquin River inflow would increase the potential for straying by smolts, which would potentially negate any benefit derived from higher inflows. Smolts straying into the south Delta would likely experience increase entrainment and predation risks and delayed migrations. The positive and negative effects of the changes in south Delta flow patterns are expected to offset each other and therefore are considered not likely to adversely affect the steelhead smolts. Implementing Interim and Restoration flows is expected to have no effect on water temperatures in the Delta, but would likely alleviate low DO conditions at the Stockton DWSC during late summer and fall. There would be no effect on Central Valley steelhead or its designated critical habitat. Implementing Interim and Restoration flows would increase San Joaquin River flow, which would dilute contaminants from agricultural drainage or other sources. This effect would likely not extend far into the Delta, because much of the increased water volume would be offset by exports at the Jones and Banks facilities. Therefore, it would likely have a slightly beneficial effect on Central Valley steelhead and its designated critical habitat in the Delta.

Flow Patterns. Central Valley steelhead migrate through the Delta as upstream migrating adults during November through January, and as juveniles and smolts emigrating on their way to the ocean during spring, peaking in April and May.

The direct effects of implementing the Interim and Restoration flows in the Delta would include increased inflow from the San Joaquin River and increased exports at the Jones and Banks export facilities (see Section 3.3, Proposed Action). The export facilities are located in the southwestern Delta and are connected by Old and Middle rivers to the San Joaquin River close to where it enters the southeastern Delta. When the export pumps are not operating, flows in Old and Middle rivers move from the upstream portions that join the San Joaquin River in the southeastern Delta downstream to the sections that join the lower portion of the river. However, when the pumps are operating, they often export such large volumes of water that flow in the downstream portions of Old and Middle rivers moves upstream toward the pumps (also referred to as reverse Old and Middle River (OMR) flow). The NMFS 2009 OCAP BO places restrictions on reverse flows in the downstream Old and Middle rivers that are intended to protect steelhead.

Increased flows often help trigger adult steelhead movement upstream, so increased San Joaquin River inflow during late fall and winter likely would trigger spawning migrations. Increased inflow would also potentially provide stronger environmental cues that would reduce steelhead straying out of the river channel into the south Delta. However, when export pumping is increased to recapture San Joaquin River inflow, increased flow toward the pumps in upper Old and Middle rivers could cause increased straying of the migrating adults into the south Delta, where their progress might be impeded by barriers and irregular flow patterns (Mesick 2001).

Reverse flows lower Old and Middle rivers and draw some Sacramento River water from upstream of the confluence of the Sacramento and San Joaquin rivers through the DCC and Georgiana Slough into the San Joaquin side of the Delta. After the Sacramento River water reaches the confluence, the reverse flows may draw more of this water upstream into the San Joaquin River and the south Delta. These flows likely cause straying and delays in the migrations of Sacramento River Central Valley steelhead (Brandes and McLain 2001). However, as a result of the NMFS 2009 OCAP BO, reverse flows in Old and Middle river will be regulated, restricting the potential effect of the Interim and Restoration flows on the Old and Middle river flows. Therefore, implementing the Interim and Restoration flows is not likely to adversely affect Central Valley steelhead during their upstream or downstream migrations through the Delta.

Increased San Joaquin River inflow would likely benefit emigrating Central Valley steelhead. Tagging studies conducted for VAMP have demonstrated that fall-run Chinook smolt survival through the south and central Delta is positively correlated with San Joaquin River inflow (San Joaquin River Group Authority (SJRGA) 2001- 2009). Higher inflow likely reduces the transit time of the smolts through the Delta, thus reducing their time of exposure to predators, poor water quality, low food supply, and other mortality factors. High inflow also helps to prevent straying into the south Delta, where habitat conditions are especially poor and risks of entrainment greatly increase. Effects of increased San Joaquin River inflow on Central Valley steelhead emigrating from the San Joaquin River are expected to be similar.

Figure 6-1 displays the mean percent changes between baseline conditions and the Proposed Action in simulated monthly mean reverse flow for each water year type. The Proposed Action is expected to result in increased mean reverse flow (i.e., upstream flow) for the Old and Middle rivers combined for nearly all water year types (based on the Sacramento Valley Index) in most months. The largest increases in mean reverse flow would occur in April. Reverse flows increased an average of about 10 percent in April for all year types, except critical years, and reverse flow during April increased more than 10 percent at least 40 percent of the time. The largest decreases in mean reverse flow relative to baseline conditions would occur in February and March. These changes in Old and Middle river flows are within the limits established under the BO and existing laws and regulations, and therefore would not violate existing regulations.

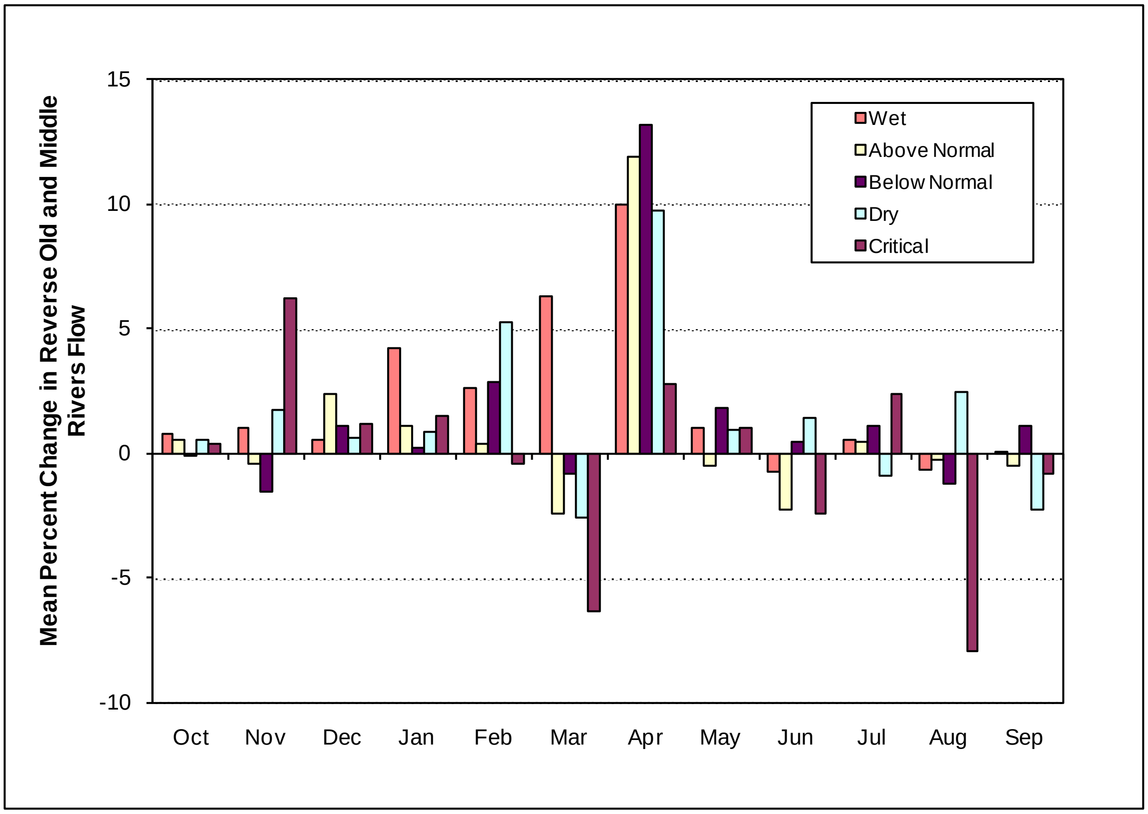

Figure 6-1.
Mean Percent Changes in Reverse Flow of Old and Middle Rivers Combined

San Joaquin River inflows and reverse Old and Middle rivers flow have counteracting effects on fish distribution with respect to the south Delta, and the ratio of inflow to reverse flow was used to evaluate the net effect of these flows on fish distributions. The ratio is particularly useful for evaluations when the Proposed Action results in high inflow and high reverse flow, as expected for April of most years. Figure 6-2 shows the mean percent changes from baseline conditions to the Proposed Action in the ratio of simulated monthly mean San Joaquin River flow at Vernalis to simulated monthly mean reverse flow of Old and Middle rivers for each water year type. Increases in the ratio were more prevalent than decreases, indicating that, on average, the Proposed Action would increase San Joaquin River inflow more than it would increase reverse flows in the Old and Middle rivers. The greatest mean increases in the ratio are predicted for March and April. The predicted ratios declined more than 10 percent in, at most, about 13 percent of years in any month.

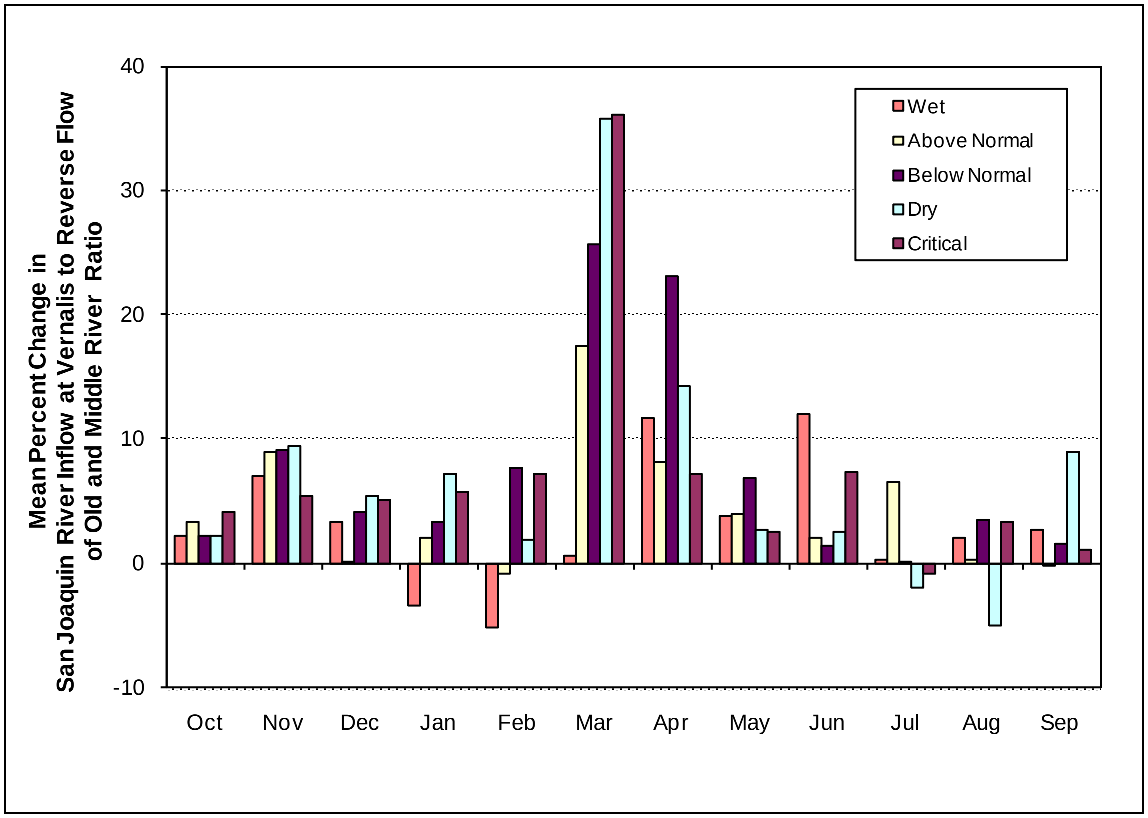

Figure 6-2.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined

Increased San Joaquin River inflow would potentially improve conditions for emigrating steelhead in the spring. However, increased reverse flows in upper Old and Middle rivers and higher levels of pumping required to recapture the increased inflow from Interim and Restoration flows would potentially increase rates of straying by the smolts. Straying of smolts into the south Delta would likely increase entrainment and predation risks and delay migrations. When such conditions threaten to exceed the limits set by the BO RPAs or regulations in effect at the time, Reclamation would implement actions to reduce pumping and/or inflow to assure compliance and maintain conditions that have been determined in the operation BOs to avoid adverse effects to listed fishes.

Water Temperature. The Proposed Action would increase inflow from the San Joaquin River to the Delta during adult migration and smolt emigration periods of steelhead. However, the increased inflow is expected to have no effect on water temperatures in the Delta, and, therefore, have no temperature-related effect on Central Valley steelhead in the south Delta.

The south Delta often has poorer water temperature conditions than the rest of the Delta for Delta fishes, especially during late summer and early fall (Nobriga et al. 2008, Feyrer 2004, Kimmerer 2004). Water temperatures are especially important for steelhead adults migrating upstream in the San Joaquin River beginning in late summer, and smolts migrating downstream through the Delta in the spring, because steelhead have lower temperature tolerances than other Delta fish species.

SJR5Q modeling results indicate that immediately downstream from the confluence with the Merced River, the proportionately small volume of Interim and Restorations flows (relative to existing flows in the San Joaquin River) would have little effect on water temperatures in the San Joaquin River, and therefore on water temperatures in the south Delta. These results show that effects of the Merced River on water temperature of the San Joaquin River would not be different under the Proposed Action and baseline conditions (model results are presented in Appendix H, "Modeling," of the Draft PEIS/R; Reclamation and DWR 2011).

Water Quality. The Proposed Action would increase inflow from the San Joaquin River to the Delta during adult steelhead migration and smolt emigration periods of steelhead. Increased inflow is expected to improve DO conditions for migration of adult steelhead in the San Joaquin River and therefore in the south Delta. The improved water quality would likely have a beneficial effect on Central Valley steelhead.

The Proposed Action would potentially affect DO in the San Joaquin River near the Stockton DWSC. DO levels at the Stockton DWSC are often low during late summer and early fall because of high water temperatures, algal biomass, and low river flow (Giovannini 2005, Lee and Jones-Lee 2003). The Proposed Action is expected to result in increased mean San Joaquin River inflow for nearly all water year types in every month. Figure 6-3 shows the mean percent changes from baseline conditions the Proposed Action in simulated monthly mean flow of the San Joaquin River at Vernalis for each water year type. The greatest mean increases in San Joaquin River flow are predicted for March and April (from 6,324 cfs to 6,764 cfs and 6,054 cfs to 7,250 cfs, respectively). The only mean decreases in flow were predicted for January and February (from 4,794 cfs to 4,765 cfs and 6,452 to 6,282 cfs, respectively). Little change in inflow is expected for July through September, while no more than 9 percent of years in any month had flow reductions of greater than 10 percent. It is assumed that operations of the Head of Old River Barrier, which is installed during fall of most years to increase San Joaquin River flow past Stockton, would not change. Therefore, changes in DO concentrations under the Proposed Action would have no effect on Central Valley steelhead.

Habitat Modification. A number of barriers are seasonally installed in the south Delta to control water levels and water quality for agricultural diversions. A barrier is also installed at the head of Old River during fall to increase flow in the San Joaquin River, and during spring to reduce straying of steelhead smolts from the San Joaquin River. Once in the south Delta, fish migrations may be impeded by the barriers (Hallock et al. 1970). Large fish such as steelhead are especially vulnerable to effects of such barriers. The Proposed Action is expected to cause no direct effect on habitat connectivity in the Delta, but could potentially reduce the chances of fish entering the south Delta, where barriers may impede their migrations. In addition, the Proposed Action would be operated consistent with applicable laws, regulations, BOs, and court orders (which provide additional protection to fish) in place at the time the water is recaptured.

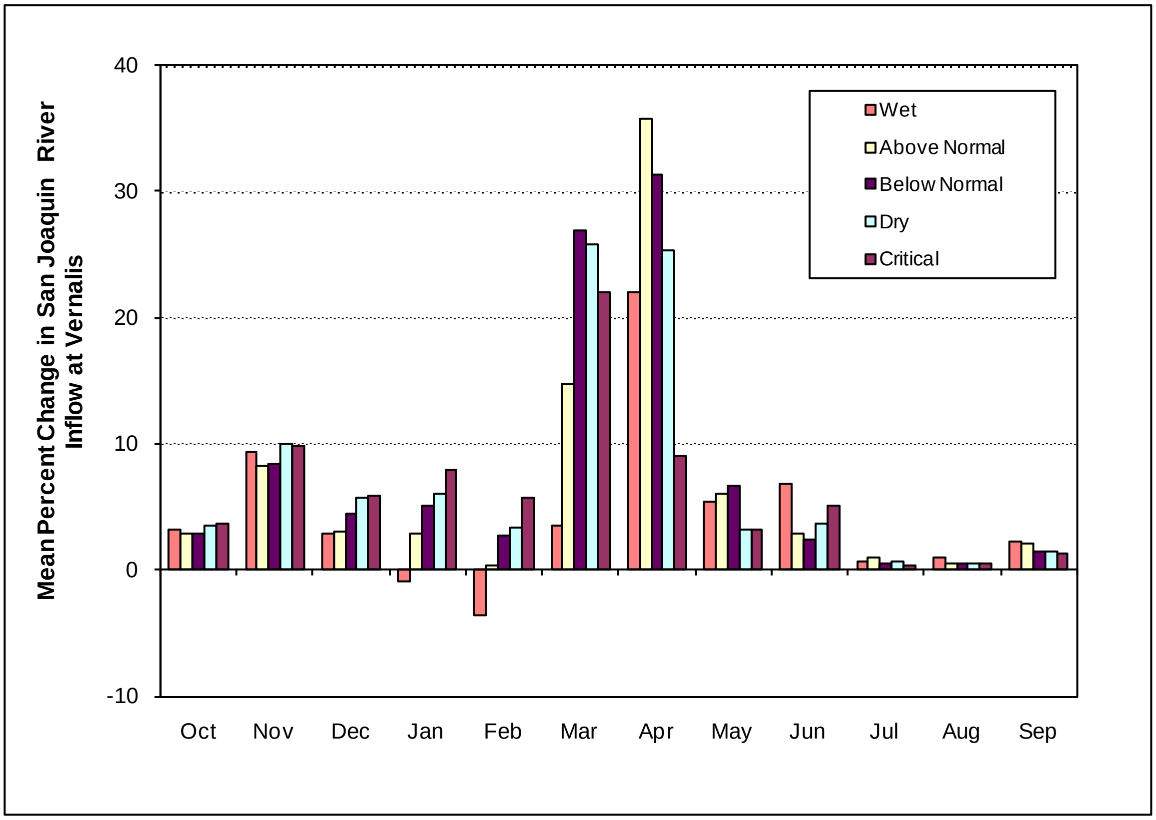

Figure 6-3.
Mean Percent Changes in San Joaquin River Flow at Vernalis

Predation. The Proposed Action is expected to result in lower average fish predation rates on Central Valley steelhead because it would produce flow patterns that would help to keep fish from the south Delta where predation rates are high. The flow effects would be more favorable during March and April, when steelhead smolts may be present.

The potential effects of the Proposed Action on predation are expected to be largely determined by the distribution of fish with respect to the south Delta. Predation rates are higher for most fishes in the south Delta than in other parts of the Delta for a variety of reasons: (1) turbidity is generally lower in the south Delta and, therefore, fish are more visible to their predators (Nobriga et al. 2008; Feyrer et al. 2007); (2) many of the structures and facilities in the south Delta provide excellent conditions for piscivorous fish, particularly the Clifton Court Forebay and fish louver screens at the Jones and Banks pumping facilities (Reclamation 2008); and (3) recent invasions by the submerged plant, *Egeria densa*, provide favorable habitat conditions for black bass species, which prey on juvenile steelhead (Nobriga and Feyrer 2007, Nobriga et al. 2005). As shown in Figure 6-2, the Proposed Action is predicted to increase the ratio of San Joaquin River inflow to reverse flows in Old and Middle rivers in most years, which could redistribute fish populations such that fewer fish would be present in the south Delta where predation is high. The increases would be greatest for March and April, a period during which steelhead smolts may be present in the Delta.

Food Web Support. Habitat conditions are considered poor in the south Delta because of factors such as high water temperatures, and low turbidity (which likely reduce the abundance of prey species). Increased water temperatures do not favor native invertebrates, and have the potential to reduce the abundance of available food resources for steelhead. Low turbidity reduces feeding rates for visual feeding fishes such as steelhead. The reason for this is not entirely understood, but it is believed that turbidity provides visual contrast that helps fish find their prey. Because the Proposed Action is predicted to increase the ratio of San Joaquin River inflow to reverse flow in Old and Middle rivers, the number of fish present in the south Delta is expected to decrease. As a result, feeding conditions would, on average, improve because there would be less fish exposed to the south Delta, and fish would move through areas where food web support is more suitable than is found in the south Delta.

Effects of Program-Level Actions. There would be no effects to steelhead in the Delta resulting from program-level actions under the Proposed Action; therefore, only effects within the San Joaquin River and its tributaries are described below. Most of the effects of program-level actions would be site-specific, often construction-related, and would primarily affect only the Restoration Area. Because most of the activity would occur before any potential recolonization of steelhead, there would be few potential effects. Therefore, only those with a potential long-term change are described below.

San Joaquin River and Tributaries

Habitat Modification. All fish in the Restoration Area would be subject to potential effects related to geomorphic processes as a consequence of channel alterations during and following Restoration actions. Actions implemented under the Proposed Action are expected to increase the quantity and quality of instream, riparian, and floodplain habitat over the long term, providing benefits to steelhead once they recolonize the Restoration Area. Improvement of existing floodplain habitat and creation of new floodplains would benefit rearing steelhead, and would improve ecosystem functions such as primary and secondary production, thus providing benefits to all fish in the river. Floodplain habitat offers abundant, high-quality food and low predator densities to increase juvenile growth.

Improvements to aquatic habitat, including creation of pools and instream cover, would provide enhanced habitat for juvenile and adult rearing, feeding, and spawning for representative fish species and most other fishes. Enhanced spawning gravel in Reach 1 of the Restoration Area would provide additional habitat suitable for spawning and incubation by steelhead. Removing or modifying barriers that restrict fish movement would increase access to available habitat in all reaches of the Restoration Area.

Currently, designs and environmental documentation are being conducted for site specific restoration in Reach 2B (Mendota Pool Bypass) and Reach 4B. Because planning and designs for modifications in these channels are still preliminary, these actions are described at a program-level of detail in Chapter 3.0, “Description of the Proposed Action.” Project-level consultation for these actions will occur subsequent to the completion of detailed planning and design. For purposes of this BA, it is assumed that restoration designs and channel improvements in these and other reaches would occur as described in Chapter 3.0, "Description of Proposed Action." And would provide improved access for migrating fish and potentially improved access to floodplain habitat.

Overall, these and other habitat improvement actions would result in beneficial effects to Central Valley steelhead after they recolonize the Restoration Area.

Entrainment. Restoration actions implemented under the Proposed Action could include improving existing fish screens and installing new fish screens at the Arroyo Canal, the Chowchilla Bypass Bifurcation Structure, and at small pumps and diversions throughout the Restoration Area. This would result in reduced entrainment potential, which would be beneficial to recolonized steelhead.

Food Web Support. Actions to restore and improve riparian and aquatic habitat would increase benthic and terrestrial food organism production. The reintroduction of Chinook salmon would increase nutrient input to the river (via carcasses), leading to improved river food web support and associated benefits to all of the representative fish species. Increased abundance and diversity of aquatic and riparian vegetation through restoration of floodplains and reconnection of floodplains with the river channel would lead to increased secondary aquatic production, providing invertebrate food resources relied on by most life stages of representative fish species. The resulting improvements to food web support would be beneficial to Central Valley steelhead adults and juveniles after they recolonize the Restoration Area.

Predation. Restoration actions implemented under the Proposed Action, including fish passage structures and restoration of side channels and backwater habitat, could increase predation risk for juvenile steelhead. However, implementing Conservation Measures CVS-1, CVS-2, EFH-1 and EFH-2 of the Conservation Strategy (Table 3-4) would offset potential adverse effects on juvenile steelhead. Restoration actions implemented under the Proposed Action, including isolating or filling gravel pits in Reach 1 and restoring floodplain habitat, would benefit steelhead juveniles in the Restoration Area, which would in turn benefit steelhead that recolonize the Restoration Area.

Sacramento River Winter-Run Chinook Salmon ESU and Central Valley Spring-Run Chinook Salmon ESU

The ranges of Sacramento River winter-run and Central Valley spring-run Chinook salmon overlap very little with the Action Area. Both runs spawn in the Sacramento River or its tributaries, and both use the Sacramento River as a migration corridor through the Delta. However, upstream migrating adults and outmigrating smolts from both runs do stray into the Action Area, particularly when the DCC gates are open and/or south Delta export rates are high relative to San Joaquin River inflow, which causes highly negative flows in the Old and Middle rivers north of the export facilities. Overall, the Proposed Action is not likely to adversely affect Sacramento River winter-run and Central Valley spring-run Chinook salmon or the designated critical habitats.

Effects of Project-Level Actions. Potential effects of implementing Interim and Restoration flows on Sacramento River winter-run and Central Valley spring-run Chinook salmon are similar, and also are the same as effects previously described for Central Valley steelhead from the Sacramento River, except that the timings of migrations are different.

Winter-run Chinook salmon migrate upstream through the Delta from approximately December through June, and smolts emigrate through the Delta from January through May. Implementing Interim and Restoration flows is expected to increase flow in the San Joaquin River and Delta inflow. No changes in Sacramento River flows towards the Old and Middle rivers in the central Delta or in operation of the DCC are anticipated. Therefore, fewer adults or smolts would likely stray from the Sacramento River into the San Joaquin River side of the Delta, reducing transit time for the fish and improving their survival rate. The effect on straying is expected to be small but beneficial; therefore, implementing Interim and Restoration flows is considered not likely to adversely affect Sacramento River winter-run Chinook salmon or its designated critical habitat.

Spring-run Chinook salmon migrate upstream through the Delta from approximately March through June. Timing of smolt emigration varies because smolt may emigrate as YOY or as yearlings (Reclamation 2008). As a result, most spring-run emigration occurs either during November and December or during March through May. As indicated for winter-run Chinook salmon, implementing the Proposed Action would increase San Joaquin River inflow through the south Delta, which would potentially reduce straying from the Sacramento River. The effect on straying is expected to be small; therefore, implementing the Proposed Action is considered not likely to adversely affect Central Valley spring-run Chinook salmon or its designated critical habitat.

Effects of Program-Level Actions. There are no effects to either Sacramento River winter-run Chinook salmon or Central Valley spring-run Chinook salmon caused by the program-level actions.

Central Valley Fall-Run Chinook Salmon ESU

Effects of Program-Level Actions. Potential effects of implementing Interim and Restoration flows on Central Valley fall-run Chinook salmon are similar as effects previously described for Central Valley steelhead, except that the timings of migrations are different.

San Joaquin River and Tributaries

Flow Patterns. Flows in the tributaries would meet the target flows for fall-run Chinook salmon (data provided in Appendix B) as follows:

- **Merced River** – In April of above-normal water years (San Joaquin Valley 60-20-20 Index), Merced River flows under the Proposed Action are lower than under baseline conditions. Decreases in required releases on the Merced River could occur in April of above normal water years, and could allow refilling of Lake McClure and Lake McSwain, which would provide cooler water for release later in the year than would otherwise be available. Therefore, the Proposed Action is not likely to adversely affect fall-run Chinook salmon in the Merced River.

- **Tuolumne River –** Flows in the Tuolumne River would meet target flows for fall-run Chinook salmon under the Proposed Action. Therefore, there would be no effect to fall-run Chinook salmon resulting from the Proposed Action.
- **Stanislaus River –** Under baseline conditions and the Proposed Action, simulated flows on the Stanislaus River in March of critical, dry and below normal water years (San Joaquin Valley 60-20-20 Index) do not always meet the flow standard set for migrating Chinook salmon and fall-run Chinook salmon (2,000 cfs). Therefore, it is reasonable to anticipate that under the Proposed Action, flows would be released from New Melones Dam to benefit or minimize effects to Stanislaus River steelhead. Additionally, WOMT would manage the flows to provide flows needed to protect steelhead outmigration in years where VAMP flow requirements at Vernalis and the Vernalis water quality standard would otherwise result in reduced flows in the Stanislaus River. Therefore, the Proposed Action is not likely to adversely affect fall-run Chinook salmon in the Stanislaus River.

Habitat Modification. Habitat modifications for fall-run Chinook salmon are similar to those described above for Central Valley steelhead.

Water Temperature. While timing of effects would be slightly different, fall-run Chinook salmon would be affected similarly from changes in water temperature to those described above for Central Valley steelhead.

Water Quality. Fall-run Chinook salmon would be affected similarly from changes in water quality to those described above for Central Valley steelhead.

Disease. Fall-run Chinook salmon would be affected similarly from changes in potential diseases to those described above for Central Valley steelhead.

Southern DPS of North American Green Sturgeon

Within the Action Area, the geographic range and designated critical habitat of North American green sturgeon includes the south Delta. Overall, the Proposed Action is not likely to adversely affect the Southern DPS of the North American green sturgeon and its designated critical habitat.

Effects of Project-Level Actions. It is unlikely that green sturgeon spawn in the San Joaquin River or its tributaries, and their historic presence in the Restoration Area is speculative. Adult green sturgeon pass through the Delta and migrate up the Sacramento River to spawn from April through June (Moyle 2002). Potential effects to southern DPS of the North American green sturgeon and its designated critical habitat are described below.

San Joaquin River and Tributaries. Green sturgeon in the San Joaquin River would be affected by the water temperature and water quality conditions as described above for Central Valley steelhead, however, green sturgeon have been shown to be more vulnerable to selenium than other fishes. It is unknown whether Interim or Restoration flows will result in an increase in selenium or methyl-mercury until further monitoring results are provided.

Changes in tributary flows and changes to habitat within the Restoration Area that would occur under the Proposed Action are not likely to adversely affect green sturgeon

South Delta. Juvenile green sturgeon are entrained in the Jones and Banks export facilities, but numbers are low relative to those of most Delta species and take limits of green sturgeon at the facilities have never been reached. It may be assumed that sturgeon are adversely affected by the same poor conditions in the south Delta that affect steelhead, described above, and that they would similarly benefit from conditions that reduced their exposure to this portion of the Delta. Adult and juvenile green sturgeon may be found in the Delta at any time of year.

Because they reside in the Delta throughout the year, green sturgeon would be potentially affected by changes in Delta flow patterns resulting from implementing Interim or Restoration flows in any month. It is unknown but assumed that San Joaquin River inflows and increased flows in southeast Delta channels leading into the south Delta affect movement of adult or juvenile green sturgeon. Flow conditions expected under Interim and Restoration flows would likely result in reduced green sturgeon movement or no change in movement to the south Delta, and it is expected that this also would be true for green sturgeon. Therefore, implementing Interim and Restoration flows is considered not likely to adversely affect Southern DPS of the North American green sturgeon or its designated critical habitat.

Effects of Program-Level Actions. No program-level effects are anticipated for green sturgeon because their presence in the Restoration Area (where program-level actions would be implemented), even after Restoration activities are completed, is speculative.

Delta Smelt

Within the Action Area, delta smelt and its designated critical habitat are found only in the lower reaches of the San Joaquin River and in the south Delta. Overall, the Proposed Action is not likely to adversely affect delta smelt or its designated critical habitat.

Effects of Project-Level Actions. The Proposed Action is expected to have no direct effect on turbidity in the Delta, but is expected to have an indirect effect on delta smelt by moving fish away from the south Delta, where turbidity is generally low compared to other parts of the Delta. This indirect effect is not likely to adversely affect, delta smelt.

South Delta

Water Temperature. The south Delta typically has poor water temperature conditions for delta smelt, especially during late summer and early fall (Nobriga et al. 2008, Feyrer 2004, Kimmerer 2004). Water temperatures would not be affected in the south Delta by implementing Interim or Restoration flows. Therefore, delta smelt would not be affected by changes to water temperature caused by Interim or Restoration flows.

Water Quality. The Proposed Action would result in an increase in DO at the Stockton DWSC during late summer and fall, and minor local reduction in pollutants at the confluence of the San Joaquin River with the Delta. These changes would not be great enough to affect delta smelt.

San Joaquin River inflow to the south Delta is expected to increase under Interim and Restoration flows. It is assumed that operations of the Head of Old River Barrier, which is installed during fall of most years to increase San Joaquin River flow past Stockton, would not change. DO levels at the Stockton DWSC are often low during late summer and early fall because of high water temperatures, algal biomass, and low river flow (Giovannini 2005, Lee and Jones-Lee 2003). The Interim and Restoration flows would likely help alleviate low DO conditions at the Stockton DWSC during late summer and fall.

The Proposed Action would increase San Joaquin River flow, which would dilute contaminants from agricultural drainage or other sources. Water quality modeling results show that the increased flow would dilute salinity of San Joaquin River inflow (see Chapter 14.0, “Hydrology – Surface Water Quality” in the PEIS/R; Reclamation and DWR 2011). Other pollutants in the river would be similarly diluted. This effect does not extend very far into the Delta, perhaps because much of the increased San Joaquin River water volume entering the Delta would be offset by exports at the Jones and Banks pumping plants. The dilution of pollutants would have a localized beneficial effect on delta smelt, and few delta smelt occur in the portion of the Delta that would be affected by the dilution effects. Therefore, Interim and Restoration flows would not result in adverse effects to delta smelt from contaminant exposure.

The Proposed Action would likely have a persistent indirect effect on the average turbidity to which delta smelt would be exposed. The south Delta has turbidities substantially lower than other regions of the Delta (Nobriga et al. 2008), which results in poor conditions for delta smelt. The Proposed Action is not expected to affect this turbidity, and therefore delta smelt would not be adversely affected by changes in turbidity.

Habitat Modification. Patterns of flow circulation in the Delta strongly affect fish distribution and migration behaviors. Tidal flows far exceed other flows in most Delta channels, but nontidal flows determine the net direction of water movement and thereby affect delta smelt movements.

Increased San Joaquin River flow may affect Delta outflow and X2, which is largely determined by Delta outflow and is often used to index the location of the LSZ (Kimmerer 2004). The LSZ is an area of historically high prey densities and other habitat conditions favorable for delta smelt, striped bass, and other fish species (Kimmerer 2004). The LSZ is believed to provide the best combination of habitat conditions when X2 is located downstream from the confluence of the Sacramento and San Joaquin rivers, which is the basis for the “X2 standards” (USFWS 2005). When Delta outflow is low, X2 is located in the relatively narrow channel of these rivers, whereas at higher outflows, X2 moves downstream into more open waters (Kimmerer 2004). X2 is referenced as the distance from the Golden Gate Bridge; therefore, higher X2 values correspond to greater distances upstream. The confluence of the two rivers is at about 81 kilometers (km) from the Golden Gate Bridge; thus, increases in X2 above 81 km are considered to adversely affect habitat and food web support, while decreases in X2 below 81 km are considered to have beneficial effects.

Modeling results show that the Proposed Action would rarely appreciably affect X2. The highest expected mean upstream shift in X2 is 0.4 km for March of Dry water year types. Figure 6-4 shows the predicted maximum upstream shift in X2 for each month and year type, and the percentage of years for each month with mean monthly upstream shifts of greater than 1 km. The maximum upstream shift was about 5 km for March of a Dry water year type under the Proposed Action (Figure 6-4). Less than 5 percent of years for any month were predicted to have upstream shifts of more than 1 km. Predicted downstream shifts of X2 of more than 1 km (not shown on graph) were similarly infrequent.

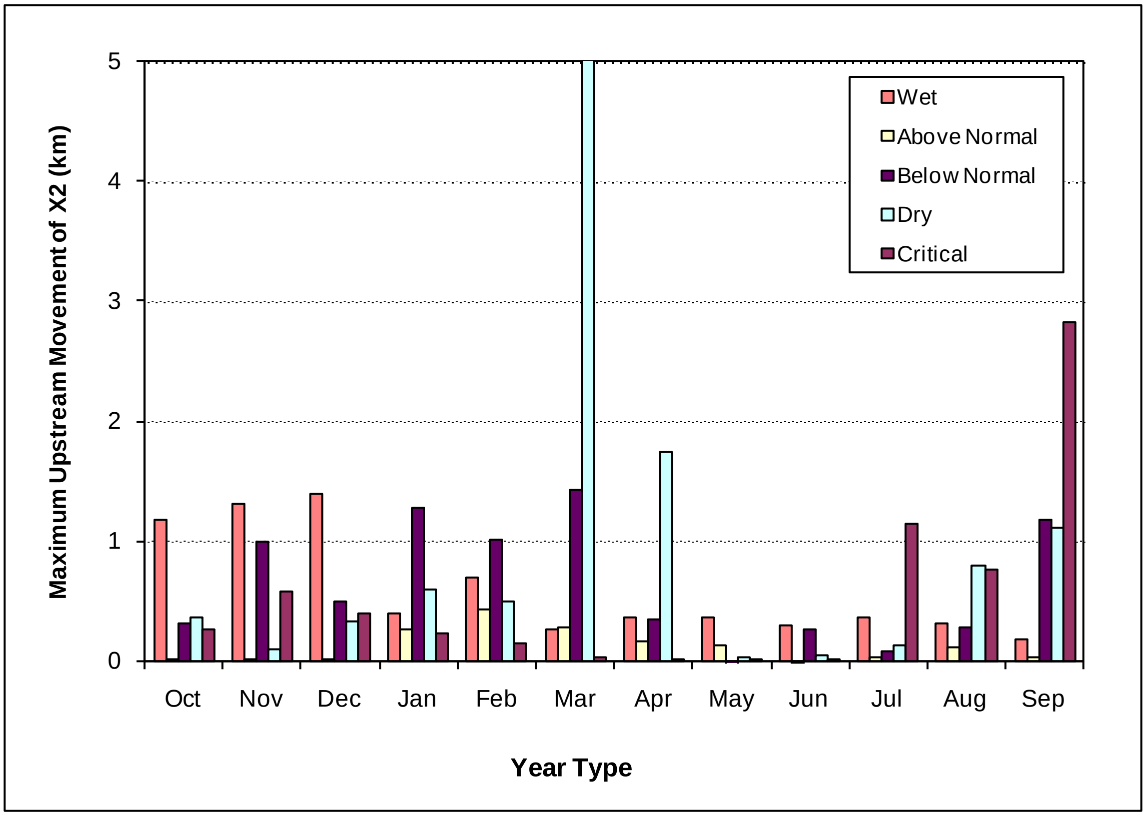

Figure 6-4.
Maximum Mean Monthly Upstream Shifts in X2

Upstream shifts that moved X2 from downstream to upstream from the confluence of the Sacramento and San Joaquin rivers could be especially deleterious for fish habitat. Using 81 km as an estimate of the location of the confluence, the Proposed Action was predicted to move X2 from downstream to upstream from the confluence of the Sacramento and San Joaquin rivers for only 3 simulated months (0.3 percent of all months simulated), and in all three cases, the shift was about 1 km. The relatively minor effect of the Proposed Action on X2 is expected because the San Joaquin River has much less effect on Delta outflow than the Sacramento River does, and increases in San Joaquin River inflow would be largely offset by increased exports from the south Delta. Because the effect of Interim and Restoration flows on Delta outflow or X2 would be negligible, the Proposed Action would not adversely affect delta smelt through changes in X2.

In years with relatively high Delta outflow, most delta smelt spawning occurs in Suisun Bay, but in years of low Delta outflow, delta smelt spawn farther upstream, including in the lower Sacramento and San Joaquin rivers. Therefore, except during years of high outflow, adult delta smelt are most likely to occur in the south Delta when they migrate upstream in December through April and before the larvae and juveniles have migrated downstream; migration is usually largely complete by June. Delta smelt that spawn in the vicinity of the lower San Joaquin River are most at risk of being drawn into the south Delta by reverse flows. Larvae are slowly transported downstream as they develop; however, larvae and many juveniles remain in upstream portions of the Delta for a month or more, particularly in years with low Delta inflow. During such periods, larvae and juveniles are at risk of being transported by reverse flows to the south Delta and the export pumps.

Predation is greater in the south Delta because (1) water clarity is generally higher in the south Delta (Feyrer et al. 2007, Nobriga et al. 2008), making prey fish more visible to their predators, (2) Clifton Court Forebay, the fish louver screens at the Jones and Banks facilities, and other facilities and structures in the south Delta, concentrate and disorient prey fish and provide ambush sites for predacious fish, and (3) recent invasions by the submerged plant *Egeria densa* provide favorable habitat conditions for black bass species, which prey heavily on young life stages of most fish species (Nobriga et al. 2005). Increased flows in the San Joaquin River through the Delta are expected to reduce the incidence of delta smelt in the south Delta.

The south Delta is generally considered poor habitat for delta smelt relative to other parts of the Delta (Feyrer 2004, Monson et al. 2007, Nobriga et al. 2008) because of risk of entrainment, high water temperatures during summer and fall, and increased predation, as described above. Therefore, delta smelt would benefit from flow patterns caused by Interim and Restoration flows that would lower the occurrence of delta smelt in the south Delta. There would be no adverse effect on delta smelt or its critical habitat resulting from Delta flow patterns.

Food Web Support. Low turbidity, which is typical in the south Delta, reduces feeding rates for visual feeding fishes. The reason for this is not entirely understood, but it is believed that turbidity provides visual contrast that helps fish find their prey. Because the Proposed Action is predicted to increase the ratio of San Joaquin River inflow to reverse flow in the Old and Middle rivers, the number of fish present in the south Delta is expected to decrease as delta smelt relocate to areas with more favorable feeding conditions. As described above, increases in X2 above 81 km are considered to adversely affect habitat and food web support, while decreases below 81 km are considered to have beneficial effects; however, Interim and Restoration flows would have negligible effects on Delta outflow or X2. Therefore, the Proposed Action would not adversely affect delta smelt through changes in food web support.

Implementing Interim and Restoration flows may have two potential effects on the availability of *Pseudodiaptomus,* the food resource for delta smelt, in the south Delta. Increased diversion at the Jones and Banks export facilities would likely entrain high numbers of copepods, including *Pseudodiaptomus*, and reduce their abundance. However, the increased San Joaquin River flows would more rapidly transport copepods produced in the south and central Delta downstream to delta smelt foraging areas in Suisun Bay and the lower Delta. The effects of increased entrainment of *Pseudodiaptomus* and more rapid downstream transport of the copepods would result in no net effect on delta smelt food resources.

Effects of Program-Level Actions. There are no program-level effects anticipated for delta smelt or its designated critical habitat because their presence in the Restoration Area (where program-level actions would be implemented), even upon completion of restoration activities, is unlikely and speculative.

6.1.2 Essential Fish Habitat

Program-level actions would directly benefit EFH for Pacific salmon in the Action Area in the same manner as described above for all ESUs of Chinook salmon and often for steelhead. Effects to Pacific salmon EFH in the tributaries would also be similar to those described for steelhead, and therefore operations may affect Pacific salmon EFH, but would not likely adversely affect Pacific salmon EFH. There would be essentially no direct or indirect effects to starry flounder EFH, which is located in the western Delta and San Francisco Bay; flow-related changes from increased San Joaquin River inflow into the south Delta from project-level actions would cause essentially no change to hydrologic conditions and fish habitat in the western Delta and San Francisco Bay. Consequently, there would be no adverse effects to EFH from either project- or program-level actions.

6.1.3 Special-Status Plants

Project-level actions are not expected to result in adverse effects on listed plant species considered in this BA, particularly with implementation of the Conservation Strategy (see Section 3.3.4 of this BA). Program-level actions, including construction activities along haul routes, in staging areas, and in project footprints, could disturb, take, or temporarily or permanently eliminate habitat for special-status plants, depending on their locations in the Restoration Area. Direct and indirect effects of project- and program-level actions on listed plant species are summarized in Table 6-4. A more detailed discussion of the project- and program-level effects of the Proposed Action on each listed species addressed in this BA follows.

**Table 6-4.
Evaluation of Potential Effects of Proposed Action on Federally Listed Plant Species in Restoration Area**

Species and Status[1]	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	Program-Level Effects
Vernal pool plant species: • Succulent owl's-clover (CH) • Hoover's spurge (CH) • Colusa grass (CH) • San Joaquin Valley Orcutt grass (CH) • Hairy Orcutt grass (CH)	Federally listed vernal pool plant species are known to occur in uplands adjacent to the San Joaquin River and bypasses. Vernal pool habitat is present adjacent to Reaches 1A, 4B2, and 5 (but not in the San Joaquin River corridor between the existing banks and levees) and the Eastside and Mariposa bypasses. Potentially suitable seasonal wetland habitat could be present in the Eastside and Mariposa bypasses.	**Moderate.** Flows would be restricted to the channel, and these areas are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees, and vernal pool habitats along Reach 1A would not be affected. Vernal pool plants could be adversely affected if their habitats are inundated too long during the growing season for the plants to complete their life cycles. Interim and Restoration flows could increase the extent, duration, or frequency of inundation in vernal pool habitats that may be present along the Eastside and Mariposa bypasses. The Restoration Area is unlikely to contain the primary constituent elements for vernal pool plants. The maximum amount of critical habitat that could be affected by flows represents a small fraction of the critical habitat designated for these species.	**High.** Habitat would be potentially disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct fill of vernal pools or could indirectly affect hydrology and ecosystem function during work in upland habitats. Program-level actions in Reaches 1A, 4B2, and 5 could affect adjacent critical habitat. Similar activities could occur in the Eastside and Mariposa bypasses and could affect designated critical habitats. Construction related to project footprints, haul routes, and staging areas could modify primary constituent elements for critical habitat in these areas.
Palmate-bracted birds-beak	This species is known to occur in the vicinity of the Restoration Area near Reach 3 and the Chowchilla Bypass. Suitable habitat for this species may be present in the Restoration Area.	**Moderate.** This species is unlikely to be present on alluvial soils in areas that are seasonally inundated or periodically inundated by flood flows along the San Joaquin River. Potentially suitable habitat may be present along the Eastside Bypass, which could be affected by flows.	**Moderate.** Activities that involve removing vegetation and disturbing the ground surface could result in direct removal or mortality of palmate-bracted birds-beak, if it is present, or in removal or degradation of suitable habitat as a result of site alteration.

Table 6-4.
Evaluation of Potential Effects of Proposed Action on Federally Listed Plant Species in Restoration Area (contd.)

Species and Status[1]	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	**Program-Level Effects**
Greene's tuctoria (CH)	Although this species was historically known to occur in vernal pool habitat near the Stanislaus and Tuolumne rivers, it is not known to occur in the Action Area.	**None.** This species is not known to occur in the Restoration Area and, therefore, would not be affected by project-level actions. Critical habitat is not designated in the Restoration Area; therefore, none would be affected by project-level actions.	**None.** This species is not known to occur in the Restoration Area and, therefore, would not be affected by program-level actions. Critical habitat is not designated in the Restoration Area; therefore, none would be affected by project-level actions.

Notes:
1 Legal Status Definition:
CH = Designated Critical Habitat
2 Describes potential effects that would be avoided and minimized by conservation measures of the Conservation Strategy (Table 3-4).
3 Potential for Effects Definitions:
High: The species is expected or known to occur in multiple areas or large geographic areas that could be affected by major construction or ground disturbance. The potential for adverse effects is considered high given the rarity of the species and the potential magnitude of the effects.
Moderate: Habitat conditions, behavior of the species, known occurrences in the project vicinity, or other factors indicate a relatively high likelihood that the species would occur in the Action Area. The potential for adverse effects is considered moderate given the rarity of the species and the potential magnitude of the effects.
Low: Suitable habitat is available in the Action Area; however, there are few to no indicators that the species might be present, and/or potential habitat is not likely to be adversely affected by the proposed activities or the activities would be beneficial. The potential for adverse effects is considered low given the rarity of the species and the potential magnitude of the effects.

Vernal Pool Plant Species (Succulent Owl's-Clover, Hoover's Spurge, Colusa Grass, San Joaquin Valley Orcutt Grass, and Hairy Orcutt Grass)

The San Joaquin River downstream from Friant Dam historically has been and currently is being managed to convey flows much later into spring and summer than ephemeral wetland habitats that support vernal pool plant species. Because plants endemic to vernal pools are not adapted to riverine habitats that are periodically flooded in summer and convey high-velocity flows, vernal pool plant species are not expected to be present in the channel where Interim and Restoration flows would be conveyed. However, because habitat mapping has not been completed in these areas, and because vernal pools are known to occur, or have occurred historically, outside the bypass levees in adjacent lands, vernal pools or other seasonal wetland habitats may be present on existing levees. Interim and Restoration flows could increase the extent, duration, or frequency of inundation in these habitats, and Federally listed vernal pool plants could be adversely affected if these habitats are inundated too long during the growing season for the plants to complete their life cycles.

Habitat mapping would be completed along and adjacent to Reaches 1A and 4B and the Eastside and Mariposa bypasses where vernal pools may occur in the areas where program-level actions may be conducted. Where suitable habitat may be present, conservation measures would be implemented to avoid, minimize, and compensate for effects on potential vernal pool plants and habitat (see Conservation Measures VP-1, VP-2, and VP-3 in Table 3-4). Therefore, implementing the Proposed Action would not directly or indirectly affect aquatic habitat for vernal pool plant species and would not affect vernal pool plants.

The following discussion address the potential effects of project- and program-level actions on vernal pool plant species, potential effects on Federally designated critical habitat for vernal pool plant species, and on the goals, objectives, strategies, and criteria identified in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005).

Effects of Project-Level Actions. Vernal pools and other seasonal wetlands that have potential to support special-status plant species could be adversely affected by reoperation of Friant Dam; however, with implementation of the conservation strategy, project-level actions would not adversely affect vernal pool plant species (see Section 3.3.4 of this BA). Five Federally listed vernal pool plant species are either known to or could occur in the Restoration Area in vernal pool habitats: succulent owl’s-clover, Hoover’s spurge, Colusa grass, San Joaquin Valley Orcutt grass, and hairy Orcutt grass.

Four of these plant species (succulent owl’s-clover, Colusa grass, San Joaquin Valley Orcutt grass, and hairy Orcutt grass) could occur in northern hardpan and northern claypan vernal pools found on alluvial terraces adjacent to Reach 1A. Because vernal pools would be located on high terraces outside the Restoration Area, Interim and Restoration flows would not substantially alter the hydrologic regime in vernal pool systems above Reach 1A, and vernal pool plant species would not be affected.

Hoover’s spurge and Colusa grass are known to occur in the vicinity of the Restoration Area in the Merced NWR, and habitat potentially suitable for these species exists in northern hardpan and northern claypan vernal pools on alluvial terraces in and adjacent to Reaches 4B and 5 and the Eastside and Mariposa bypasses. The likelihood that Hoover’s spurge is present in the Restoration Area is low because the Merced NWR occurrence is the only occurrence out of 29 documented in the CNDDB that is located in the San Joaquin Valley Vernal Pool Region (USFWS 2005), approximately 1.5 miles east of the Eastside Bypass and outside the Action Area. This species is associated primarily with vernal pools of the Northeastern Sacramento Valley Vernal Pool Region in Butte and Tehama counties and the Southern Sierra Foothills Vernal Pool Region in Tulare County. Colusa grass could be present in any suitable vernal pool habitat in or adjacent to the Eastside Bypass, although it has not been documented in the bypass. It is unlikely that vernal pools occur in existing channels and levees, and habitat suitable for Hoover’s spurge and Colusa grass is not expected to occur in the channels where Interim and Restoration flows would be conveyed. However, because habitat mapping has not been completed in these areas, and vernal pools are known to occur, or have occurred historically, outside the bypass levees in adjacent lands, vernal pools or other seasonal wetland habitats may be present on existing levees. Interim and Restoration flows could increase the extent, duration, or frequency of inundation in these habitats, and Federally listed vernal pool plants could be adversely affected if these habitats are inundated too long during the growing season for the plants to complete their life cycles.

The Proposed Action includes Conservation Measures VP-1 and VP-2 to avoid and minimize loss of vernal pool habitat and risk of take of special-status vernal pool plants. Conservation Measure VP-3 requires Reclamation to compensate for temporary or permanent loss of vernal pool habitat, using a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. Under Conservation Measure VP-3, compensatory ratios for loss of habitat both in and out of core areas would be determined during coordination and consultation with USFWS and/or DFG, as appropriate, and in consideration of the Vernal Pool Recovery Plan goals for core areas. Therefore, potential adverse effects on Federally listed vernal pool plants would be avoided or minimized.

Effects of Program-Level Actions. Vernal pool habitat is present along Reaches 1A, 4B, and 5 and the Eastside and Mariposa bypasses. Program-level actions that involve removing vegetation and disturbing the ground surface could result in direct removal or mortality of Federally listed vernal pool plants, if they are present, or in removal or degradation of suitable habitat. Program-level actions could include conducting construction activities along haul routes, in staging areas, and in project footprints and augmenting spawning gravels. Several indirect effects on vernal pool plants have the potential to occur: changes in vegetation as a result of changes in management practices; altered hydrology from construction of new levees, haul roads, new or modified channels, or other subsequent projects; fill of vernal pool habitats; habitat fragmentation; and the introduction or spread of invasive species during construction activities.

Vernal pools along Reach 1A are outside the Restoration Area; however, creating haul roads, staging areas, or other ancillary features adjacent to Reach 1A could result in loss or degradation of vernal pools. Program-level actions in Reach 4B and the Eastside and Mariposa bypasses, particularly channel modifications along the Eastside and Mariposa bypasses, could result in fill of vernal pools. Program-level actions would not affect vernal pools in Reach 5, however, because no ground-disturbing activities or actions that could result in fill of vernal pools would occur in this reach.

Conservation measures (Table 3-4) would be implemented as part of the Conservation Strategy to offset potential adverse effects on special-status plants. Under Conservation Measures VP-1 and VP-2, potential habitat for listed vernal pool plant species would be identified and mapped and this habitat, plus a 250-foot buffer, would be avoided during construction activities to the extent feasible. Under Conservation Measure VP-3, any loss of occupied habitat that could not feasibly be avoided would be compensated for through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies, as appropriate. Therefore, potential adverse effects on Federally listed vernal pool plants would be avoided or minimized.

Critical Habitat for Vernal Pool Plant Species. Critical habitat for succulent owl's-clover, Hoover's spurge, Colusa grass, and hairy Orcutt grass is designated in the Restoration Area in the river corridor and bypass system. In Reach 1A, critical habitat has been designated on the north side of the river for succulent owl's-clover (Unit 4; 71 FR 7118) and hairy Orcutt grass (Unit 6; 71 FR 7118). The southern boundaries of these designated areas extend into the Restoration Area. These species are associated with vernal pool habitats that are located outside the river corridor. In this reach, the uplands and vernal pool complexes are separated from the river corridor by natural bluffs. In Reach 4B2 and in the Eastside and Mariposa bypasses, the Restoration Area includes critical habitat for Hoover's spurge (Units 6A–6D; 71 FR 7118). Critical habitat for Colusa grass (Unit 7D; 71 FR 7118) occurs in the Restoration Area only in the Eastside Bypass. In addition, critical habitat for San Joaquin Valley Orcutt grass has been designated within 5 miles of the Restoration Area, adjacent to Reach 1A (Units 3-C and 4; 71 FR 7118).

The primary constituent elements for these vernal pool plant species generally include (1) topographic features characterized by mounds, swales, or depressions in a matrix of surrounding uplands and (2) depressional features, including isolated vernal pools with underlying restrictive soil layers that are inundated during winter rains and that continuously hold water or whose soils are saturated for a temporary period.

Effects of Project-Level Actions. All critical habitat designated for San Joaquin Valley Orcutt grass is outside the Restoration Area. Small portions of critical habitat for succulent owl's-clover and hairy Orcutt grass have been designated in the Restoration Area on alluvial terraces adjacent to Reach 1A of the San Joaquin River. The amount of critical habitat in the river channel at the approximate ordinary high-water mark is approximately 42 acres for succulent owl's-clover (Unit 4) and approximately 3 acres for hairy Orcutt grass (Unit 6). The amount that could be affected represents a small fraction of the critical habitat designated for these species (Table 6-5).

Critical habitat for Hoover's spurge has been designated in and adjacent to the Eastside and Mariposa bypasses and Reach 4B2 of the San Joaquin River (Table 6-5). Approximately 2.2 percent of Unit 6A (1,617 acres total), 8.3 percent of Unit 6B (6,030 acres total), and 0.1 percent of Unit 6C (6,911 acres total) are within the levees of the Eastside Bypass and therefore could be directly affected by Interim and Restoration flows; however, these flows would be confined to the channel and would not inundate the full width of the levees and thus not all this acreage would be potentially affected.

Critical habitat for Colusa grass has been designated in and adjacent to the east bank of the Eastside Bypass. The estimated amount of designated critical habitat for Colusa grass in the Action Area is approximately 9 acres, or 0.1 percent of the total designated critical habitat for Colusa grass in Unit 7D (Table 6-5).

Table 6-5.
Critical Habitat for Federally Listed Vernal Pool Plants in the Restoration Area

Species	Unit Number	Total Acres in Unit	Location	Maximum Acres Designated in Action Area[1]	Maximum Percent in Action Area
Succulent owl's-clover	4C	38,038	San Joaquin River Reach 1A	42	0.1
Hoover's spurge	6A	1,617	San Joaquin River Reach 4B2 and Eastside Bypass	35	2.2
	6B	6,030	San Joaquin River Reach 4B2 and Eastside and Mariposa bypasses	501	8.3
	6C	6,911	Eastside Bypass	9	0.1
Hairy Orcutt grass	6	27,033	San Joaquin River Reach 1A	3	0.0
Colusa grass	7D	6,911	Eastside Bypass	9	0.1

Note:
[1] Based on the published ordinary high-water mark of the San Joaquin, Tuolumne, Merced, and Stanislaus rivers and aerial photograph interpretation of levee boundaries of the Eastside and Mariposa bypasses. Because Interim and Restoration flows would not inundate this entire area, these calculations are overestimates of the potential acreage of critical habitat that could be affected. Furthermore, the low-flow channels and lower floodplain terraces of the rivers and bypasses are unlikely to contain the primary constituent elements of the designated critical habitats for listed vernal pool species.

The river corridor does not contain the primary constituent elements on which succulent owl's-clover and hairy Orcutt grass depend, such as vernal pools or swales, but the species may be found in the uplands adjacent to the river corridor. Vernal pool habitats are not expected to be substantially affected by implementing the Proposed Action. The Proposed Action is designed so that Interim and Restoration flows would be largely contained within the channel, and these areas are below grade, so flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. Because reoperation of Friant Dam would not affect any of the primary constituent elements of designated critical habitat for succulent owl's-clover or hairy Orcutt grass in Reach 1A, critical habitat for these species would not be adversely affected as a result of implementing the Proposed Action.

The Action Area is unlikely to contain the primary constituent elements for vernal pool plants because vernal pools, swales, and other seasonal wetlands in an upland matrix are not found in the low-flow channel of riverine habitats or the bypasses. Although the Eastside and Mariposa bypass system is unlikely to contain vernal pool habitats, vernal pools may exist higher in the floodplain, given the soil types and presence of vernal pools in the adjacent areas. If the primary constituent elements of designated critical habitats for Hoover's spurge and Colusa grass are present in areas that would be subject to changes in hydrologic conditions related to Interim and Restoration flows, effects on designated critical habitat could occur.

Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations. Therefore, critical habitat would not be adversely affected as a result of implementing the Proposed Action.

Effects of Program-Level Actions. Program-level actions in Reach 1A, such as construction and use of haul routes and staging areas for spawning gravel augmentation or activities to fill or isolate gravel pits, could affect critical habitats for plant species designated in and adjacent to the Restoration Area: succulent owl's-clover, hairy Orcutt grass, and San Joaquin Orcutt grass. In addition, designated critical habitat for Hoover's spurge could be affected by program-level actions proposed in Reaches 4B2 and 5. Similar activities could occur in the Eastside and Mariposa bypasses and could affect designated critical habitats for this species and for Colusa grass. In addition, in the Eastside and Mariposa bypasses, structures may be modified to allow fish passage at a range of flows up to 4,500 cfs; a fish ladder may be constructed to allow upstream and downstream fish passage at a range of flows up to 4,500 cfs; and channel modifications may occur to allow fish passage under low flows. Construction of project footprints, haul routes, and staging areas could modify primary constituent elements for critical habitat in these areas.

Conservation Measures VP-1 and VP-2 require habitat potentially suitable for special-status vernal pool species to be identified, mapped, and protected by a 250-foot avoidance buffer area before construction activities begin, in order to minimize or avoid adverse effects on vernal pool habitat to the extent feasible. Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations. With implementation of the conservation strategy, the program-level actions would be unlikely to adversely affect critical habitat for vernal pool plant species.

Recovery Plan for Vernal Pool Plant Species. Succulent owl's-clover, Hoover's spurge, Colusa grass, San Joaquin Valley Orcutt grass, and hairy Orcutt grass, are all addressed in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005). The entire Restoration Area, with the exception of Reach 1B, is encompassed in the vernal pool recovery units identified in the recovery plan. Implementing the Proposed Action would not interfere with the recovery plan's goals, objectives, strategies, or criteria because the Proposed Action would not (1) substantially reduce the viability of target species, (2) reduce the habitat value or interfere with the management of conserved lands or recovery units, or (3) eliminate opportunities for conservation or recovery actions. Further, the Proposed Action would support the future enhancement and restoration of biological resources along the San Joaquin River. Therefore, implementing the Proposed Action would be unlikely to adversely affect goals, objectives, strategies, or criteria identified in recovery plans for vernal pool plant species.

Palmate-Bracted Birds-Beak

Although the proposed action is unlikely to affect palmate-bracted birds-beak, the Conservation Strategy (Table 3-4) includes conservation measures to avoid inundation of potential habitat for palmate-bracted birds-beak along the Eastside Bypass, identify and map occurrences of this species, and either protect occurrences with buffers or compensate for effects. Therefore, with implementation of the Conservation Strategy, project- and program-level actions would not adversely affect this species.

The following discussion address the potential effects of project- and program-level actions on palmate-bracted birds-beak, Federally designated critical habitat for this species, and on the recovery strategy for this species as described in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a).

Effects of Project-Level Actions. Palmate-bracted birds-beak is known to occur in the vicinity of the Restoration Area near Reach 3 and the Chowchilla Bypass. Suitable habitat (i.e., alkaline soils in valley sink scrub and alkali meadow communities and along drainage channels (USFWS 1998a)) for this species may be present in the Restoration Area.

Therefore, Interim and Restoration flows could adversely affect this species if it is present. However, flows would largely be conveyed within the existing channels in areas that are currently subject to periodic flooding. This species is unlikely to be present on alluvial soils in areas that are seasonally inundated or periodically inundated by flood flows along the San Joaquin River. Potentially suitable habitat may be present along the Eastside Bypass. The Proposed Action includes a conservation measure (PALM-1) to avoid inundation of potential habitat for palmate-bracted birds-beak along the Eastside Bypass (Table 3-4). Therefore, this species would not be adversely affected by Interim and Restoration flows.

Effects of Program-Level Actions. Program-level actions under the Proposed Action that involve removing vegetation and disturbing the ground surface could result in direct removal or mortality of palmate-bracted birds-beak, if it is present, or in removal or degradation of suitable habitat as a result of site alteration. Several indirect effects on this species have the potential to occur: changes in vegetation as a result of changes in management practices; altered hydrology from construction of new levees, haul roads, new or modified channels, or other program-level actions; habitat fragmentation; and the introduction or spread of invasive species during construction activities.

Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Conservation Measure PALM-1 (Table 3-4) requires that qualified botanists identify and map occurrences of palmate-bracted birds-beak in suitable habitat in the project footprint, and requires that a buffer be established around any occurrences of palmate-bracted birds-beak to establish areas be avoided during construction activities. Under Conservation Measure PALM-2, a compensatory conservation plan shall be developed in coordination with USFWS and DFG, as appropriate, which will require the project proponent to maintain viable plant populations in the Restoration Area and will identify compensatory measures for any populations affected. With the implementation of these conservation measures, program-level actions would not result in adverse effects on palmate-bracted birds-beak.

Critical Habitat for Palmate-Bracted Birds-Beak. No critical habitat has been designated for palmate-bracted birds-beak; therefore, implementing the Proposed Action would not adversely affect critical habitat for this species.

Recovery Plan for Palmate-Bracted Birds-Beak. Palmate-bracted birds-beak is addressed in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). Implementing the Proposed Action would not interfere with the recovery strategy for this species, which is to maintain self-sustaining populations in protected areas over the species' former range and reintroduce the species in areas where it has been extirpated. No recovery lands have been identified for this species in the Action Area; therefore, implementing the Proposed Action would not adversely affect recovery plans for palmate-bracted birds-beak.

Greene's Tuctoria

Implementing the Proposed Action would not adversely affect Greene's tuctoria because this species is not known to occur in the Action Area. Although this species historically occurred in San Joaquin, Stanislaus, Madera, and Tulare counties, known occurrences in these counties are believed to be extirpated (USFWS 2005).

Critical Habitat for Greene's Tuctoria. Critical habitat for this species has been designated in the Action Area, near the Stanislaus and Tuolumne rivers. However, this critical habitat is outside of the Restoration Area, where the project-level and program-level actions would occur. Therefore, implementing the Proposed Action would not adversely affect critical habitat for this species.

Recovery Plan for Greene's Tuctoria. Greene's tuctoria is addressed in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005). The entire Restoration Area, with the exception of Reach 1B, is encompassed in the vernal pool recovery units identified in the recovery plan. Implementing the Proposed Action would not interfere with the recovery plan's goals, objectives, strategies, or criteria because the Proposed Action would not (1) substantially reduce the viability of target species, (2) reduce the habitat value or interfere with the management of conserved lands or recovery units, or (3) eliminate opportunities for conservation or recovery actions. Further, the Proposed Action would support the future enhancement and restoration of biological resources along the San Joaquin River. Therefore, implementing the Proposed Action would be unlikely to adversely affect goals, objectives, strategies, or criteria identified in recovery plans for this vernal pool plant species.

6.1.4 Special-Status Wildlife

Project-level effects resulting from the reoperation of Friant Dam are not expected to result in adverse effects on most listed wildlife species considered in this BA, particularly with the implementation of the Conservation Strategy (see Section 3.3.4 of this BA). Program-level actions, including construction activities along haul routes, in staging areas, and in project footprints, could disturb, take, or temporarily or permanently eliminate habitat for special-status animals, depending on their locations in the Restoration Area. Direct and indirect effects of project- and program-level actions on listed wildlife species are summarized in Table 6-6. A more detailed discussion of the project- and program-level effects of the Proposed Action on each listed wildlife species follows.

The Conservation Strategy (Table 3-4) includes conservation measures to identify and map potential special-status wildlife habitat and to avoid and minimize loss and degradation of suitable habitat, loss of individuals, and take of listed species during construction activities. Any unavoidable loss of habitat for Federally listed species would be compensated for through implementation of the conservation measures. Under the Conservation Strategy (Table 3-4), potential adverse effects on Federally listed wildlife species and their habitats would be avoided or minimized and adequately compensated for.

The Proposed Action would also have beneficial effects on some special-status species. Those actions that promote establishment of riparian or emergent wetland vegetation over the long term, such as increasing floodplain habitat in Reaches 2B and 4B1, may have a potential benefit for riparian and wetland-associated species, including valley elderberry longhorn beetle and nesting birds.

Table 6-6.
Evaluation of Potential Effects from Project- and Program-Level Actions on Federally Listed Wildlife Species in Restoration Area

Species and Status[1]	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	**Program-Level Effects**
Vernal pool invertebrates: • Conservancy fairy shrimp (CH) • Longhorn fairy shrimp (CH) • Vernal pool fairy shrimp (CH) • Vernal pool tadpole shrimp (CH)	Federally listed vernal pool invertebrates are known to occur in uplands adjacent to the San Joaquin River and bypasses. Vernal pool habitat is present adjacent to Reaches 1A, 4B2, and 5 (but not within the San Joaquin River corridor between the existing banks and levees) and in the Eastside and Mariposa bypasses. Potentially suitable seasonal wetland habitat could be present in the Eastside and Mariposa bypasses. Critical habitat for vernal pool invertebrates is adjacent to Reach 1A and in Reaches 4B2 and 5 and in the Eastside and Mariposa bypasses.	**Low.** Flows would largely be conveyed within the channel, and these areas are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees, and vernal pool habitats along Reach 1A would not be affected. Potential habitat that may be present along the Eastside and Mariposa bypasses could become unsuitable for vernal pool invertebrates if vernal pools would be regularly inundated by Restoration Flows. If listed vernal pool invertebrates are present in these habitats, implementing the Proposed Action could potentially affect species. The Restoration Area is unlikely to contain the primary constituent elements for vernal pool invertebrates. The maximum amount of critical habitat that could be affected by flows represents a small fraction of the critical habitat designated for these species.	**High.** Habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct fill of vernal pools or indirectly affect hydrology and ecosystem function during work in upland habitats. Program-level actions in Reaches 1A, 4B2, and 5 could affect adjacent critical habitat. Similar activities could occur in the Eastside and Mariposa bypasses and could affect designated critical habitats. Project footprints, haul routes, and staging areas could modify primary constituent elements for critical habitat in these areas.

Table 6-6.
Evaluation of Potential Effects from Project- and Program-Level Actions on Federally Listed Wildlife Species in Restoration Area (contd.)

Species and Status1	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	**Program-Level Effects**
Valley elderberry longhorn beetle	Valley elderberry longhorn beetle is known to occur in Reaches 1A and 2, and elderberry shrubs (potential habitat) are widespread along the San Joaquin River, especially in Reaches 1 and 2. Elderberry shrubs grow rapidly and may occur in additional areas that have not been surveyed or may have grown in areas since the surveys were conducted. In addition, because exit hole surveys were not comprehensive and results may be outdated, valley elderberry longhorn beetle could occur in more shrubs.	**Low.** Because of their locations higher on the streambanks, most elderberry shrubs in the Restoration Area are not anticipated to be inundated by flows. Any larvae or pupae present in shrubs that could be temporarily inundated would likely be able to withstand conditions because they are adapted to riparian habitats that are subject to periodic inundation. In Reach 2A, where elderberry shrubs may be growing low in portions of the channel that do not receive regular flows, flows could result in damage or physiological stress to elderberry shrubs that may contain valley elderberry longhorn beetle.	**High.** Habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities, particularly where such activities are conducted near riparian habitats.
California tiger salamander (CH)	California tiger salamander is not expected to occur in the San Joaquin River corridor but may occur in uplands adjacent to the Eastside and Mariposa bypasses where vernal pool habitat is present. Critical habitat for California tiger salamander is adjacent to Reach 1A.	**Low.** The presence of vernal pools in the Eastside and Mariposa bypasses has not been confirmed, but these habitats are unlikely to exist in the channel. The releases of flows generally would be restricted to the channel and would avoid inundating vernal pools. Therefore, flows would not have a measurable direct effect on aquatic habitat for California tiger salamander.	**Moderate.** Aquatic breeding, upland forage, refuge, and dispersal habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct loss of habitats or indirectly result in elimination of areas essential for seasonal movement.

Table 6-6.
Evaluation of Potential Effects from Project- and Program-Level Actions on Federally Listed Wildlife Species in Restoration Area (contd.)

Species and Status1	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	**Program-Level Effects**
Blunt-nosed leopard lizard	Blunt-nosed leopard lizard is known to occur in uplands adjacent to the San Joaquin River and bypasses. Potentially suitable habitat may be present in the Eastside Bypass.	**Low.** Some potential exists for blunt-nosed leopard lizard to be present in areas that would be inundated by flows if individuals from existing populations outside of the levees moved into the channel when conditions were dry. If present, some individuals might not be able to escape rising flow waters that could ramp up during spring.	**High.** Habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities.
Giant garter snake	Giant garter snake is known to occur in the Mendota Pool.	**Low.** The presence of additional flows could have a beneficial effect on this species because it is highly aquatic. Water velocities would not be substantially altered because most of the pool lies outside the flow route. Because flows would be restricted to the river channel and immediately adjacent, lower floodplain surfaces, available upland habitat for this species would not be substantially inundated.	**High.** Aquatic habitat could be affected during instream work to increase channel capacity, supplement spawning gravel, fill gravel pits, modify side channels, and install fish screens or make other modification to diversion structures. Upland nesting and aestivation habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities.
Western yellow-billed cuckoo	Western yellow-billed cuckoo is rare throughout the river corridor.	**Low.** Western yellow-billed cuckoo builds nests in large trees or shrubs that would be well above the waterline during the breeding season (approximately February through August). Flows would not substantially inundate upland foraging areas for this species.	**High.** During the breeding season, potential for loss of trees and shrubs occupied by nesting birds could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities.

Table 6-6.
Evaluation of Potential Effects from Project- and Program-Level Actions on Federally Listed Wildlife Species in Restoration Area (contd.)

Species and Status1	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	**Program-Level Effects**
Least Bell's vireo	Least Bell's vireo nests in riparian scrub and woodlands. It was discovered nesting at the San Joaquin River National Wildlife Refuge in 2006 but is not expected to nest in the Restoration Area.	**Low.** The potential exists for increased flows to inundate nest sites of least Bell's vireo if they are established before releases. Although existing habitat types in these channel reaches have potential to support this species, these areas already experience periodic flood flows during spring, and flows generally would be at nearly their highest levels before the nesting season of most birds, including least Bell's vireo.	**Moderate.** During the breeding season, potential for loss of least Bell's vireo could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities.
Fresno kangaroo rat (CH)	Recent trapping surveys have not detected Fresno kangaroo rat along the San Joaquin River. Populations may still occur at Alkali Sink Ecological Reserve and Mendota Wildlife Area or other private lands where suitable habitat could exist. Critical habitat has been designated for Fresno kangaroo rat, adjacent to the Restoration Area, approximately 4 miles from Reaches 2A and 2B.	**Low.** Suitable upland habitats and occupied burrows may be located adjacent to project-level actions in the Restoration Area; however, this species would not be adversely affected along any reach or bypass because flows generally would be restricted to the river channel and lower floodplain surfaces. Critical habitat is not located in the Action Area; thus, none would be adversely modified as a result of implementing the Proposed Action.	**Moderate.** Construction activities and facility modifications are unlikely to affect known populations but could affect habitat on private land adjacent to Reach 2B that has not been surveyed. Constructing the bypass and bifurcation structure in Reach 2 could affect the primary constituent elements of designated critical habitat for Fresno kangaroo rat, depending on where the project footprint and the staging and access areas are located.
Riparian (San Joaquin Valley) woodrat	The distribution of this special-status mammal is not well known. Although this species is not known to occur in the Restoration Area, potentially suitable habitat is present.	**Low.** The only verified extant population of riparian woodrat is located on the Stanislaus River at Caswell Memorial State Park. The effect of flows on riparian communities is greatly diminished below the confluence of the Merced River; therefore, this species would not be affected.	**Low.** Riparian woodrat populations are greatly reduced and restricted in distribution, with the only known population at Caswell Memorial State Park with a possible second population near Vernalis, downstream from the Restoration Area.

Table 6-6.
Evaluation of Potential Effects from Project- and Program-Level Actions on Federally Listed Wildlife Species in Restoration Area (contd.)

Species and Status1	Potential for Occurrence	Likelihood and Description of Potential Effects[2,3]	
		Project-Level Effects	Program-Level Effects
Riparian brush rabbit	Riparian brush rabbit is unlikely to occur in the Restoration Area. It is known to occur only in limited areas near the San Joaquin River National Wildlife Refuge, downstream from proposed construction activities.	**Low.** Riparian brush rabbit is not expected to occur upstream from the confluence with the Merced River. Downstream from the Merced River, the alteration of flows resulting from the Proposed Action would be smaller than in the Restoration Area and insufficient to cause a substantial effect on riparian habitats; thus, implementing the Proposed Action would not result in adverse direct effects on the riparian brush rabbit.	**Low.** Riparian brush rabbit is known to occur only in limited areas near San Joaquin River National Wildlife Refuge, downstream from proposed construction activities.
San Joaquin kit fox	San Joaquin kit fox has been observed in the Restoration Area.	**Low.** Water from the flow releases would be restricted to the channel and adjacent lower floodplain surfaces, habitats that are not suitable for denning. San Joaquin kit fox may forage and disperse through the river corridor or the Eastside Bypass; however, implementing the Proposed Action would not affect the ability of this species to carry out these activities.	**Moderate.** Loss of or disturbance to dens could occur during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications to channels in the bypass system; or other ground-disturbing activities.

Source: Compiled by AECOM in 2010
Notes:
[1] Legal Status Definitions:
CH = Designated Critical Habitat
[2] Describes potential effects that would be avoided and minimized by conservation measures of the Conservation Strategy (Table 3-4).
[3] Potential for Effects Definitions:
High: The species is expected or known to occur in multiple areas or large geographic areas that could be affected by major construction or ground disturbance. The potential for adverse effects is considered high given the rarity of the species and the potential magnitude of the effects.
Moderate: Habitat conditions, behavior of the species, known occurrences in the project vicinity, or other factors indicate a relatively high likelihood that the species would occur in the Action Area. The potential for adverse effects is considered moderate given the rarity of the species and the potential magnitude of the effects.
Low: Suitable habitat is available in the Action Area; however, there are few to no indicators that the species might be present, and/or potential habitat is not likely to be adversely affected by the proposed activities, or the activities would be beneficial. The potential for adverse effects is considered low given the rarity of the species and the potential magnitude of the effects.

Vernal Pool Invertebrates (Conservancy Fairy Shrimp, Longhorn Fairy Shrimp, Vernal Pool Fairy Shrimp, and Vernal Pool Tadpole Shrimp)

Because of the low likelihood that suitable habitat for vernal pool invertebrates would be present within the bypass levees, because Interim and Restoration flows would largely be conveyed within the channel, and because releases would be monitored, the Proposed Action would not result in measurable adverse effects on Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, or vernal pool tadpole shrimp.

Habitat mapping would be completed along and adjacent to Reaches 1A and 4B and the Eastside and Mariposa bypasses where vernal pools may occur in the areas where Settlement-related actions may be conducted (Conservation Measure VP-1). Where suitable habitat may be present, conservation measures would be implemented to avoid, minimize, and compensate for effects on potential vernal pool habitat (Conservation Measures VP-2 and VP3).

The following discussion addresses the potential effects of project- and program-level actions on vernal pool invertebrates, Federally designated critical habitat for these species, and on the recovery strategy for these species as described in the *Recovery Plan for Vernal Pool Ecosystems of California and Southern Oregon* (USFWS 2005).

Effects of Project-Level Actions. Four Federally listed vernal pool invertebrates have potential to be affected by the Proposed Action: Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. These species are associated with vernal pool and seasonal wetland habitats and are not expected to occur in riverine habitats. Vernal pools and seasonal wetlands suitable for these vernal pool invertebrates are not likely to be present in the San Joaquin River corridor (e.g., between the existing banks or levees). Further, the Proposed Action is designed so that Interim and Restoration flows would largely be conveyed within the channel, and these areas are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. In addition, the Proposed Action includes seepage management and monitoring that would prevent long-term seepage-related effects on vernal pools and associated listed invertebrates outside the bypass levees. Therefore, Interim and Restoration flows are not likely to affect these species in these areas.

The presence of vernal pool or seasonal wetland habitat suitable for supporting vernal pool invertebrates in the Eastside and Mariposa bypasses is unknown. These bypasses were created in uplands that historically contained northern claypan vernal pools. Land conversion for agricultural development, subsequent hydrologic modification related to creating the bypasses, and agricultural diversions and discharge have eliminated natural vernal pools from many areas. However, because of the high clay content of soils in the area, depressions caused by previous construction activities in upland habitats still tend to hold rainwater for an extended period; therefore, soil and hydrologic conditions may be suitable to support vernal pool invertebrates in some areas.

Baseline conditions in the bypasses are unlikely to be suitable for listed vernal pool invertebrates because the channels are regularly inundated during seasonal flood flows. A reconnaissance-level survey of the Eastside Bypass from West Washington Road to Sandy Mush Road was conducted in February and March 2000 (DFG 2000). In February, the only characteristic vernal pool invertebrates observed in rainwater-filled depressions in the Eastside Bypass were early successional invertebrates, such as ostracods (seed shrimp) and ceriodaphnid cladocerans (water fleas). Dytiscid larvae and adults (predaceous diving beetles) and exoskeletons of crayfish (*Procambarus* sp.) were also commonly encountered. No plant species characteristic of vernal pools surrounded the pools; cocklebur was the dominant plant species in these areas. In March, most of the pools observed during the previous survey were completely submerged under a continuous sheet of flowing water, likely the result of flood releases down the San Joaquin River. Large fish such as carp, as well as adult western toads (*Bufo boreas*), were observed in some of the deeper areas. The few isolated pools that remained contained only a few invertebrates, such as Dytiscid larvae. The cladocerans and ostracods that dominated the pools during previous surveys were no longer evident.

Although listed vernal pool invertebrates are unlikely to occur in the channels in the Eastside and Mariposa bypasses, seasonal wetland habitat may be present between existing levees. These habitats could become unsuitable for vernal pool invertebrates if they were regularly inundated by Restoration Flows, which could be up to 1,300 cfs in April, May, and June. If listed vernal pool invertebrates are present in these habitats, implementing Interim and Restoration flows that would extend beyond the existing channel and lower floodplain terraces could potentially affect these species.

The Conservation Strategy (Table 3-4) includes the following conservation measures to reduce potential effects on these species: Conservation Measure VP-1, which requires the lead agencies to identify and map vernal pools and other seasonal wetland habitats potentially suitable for listed vernal pool invertebrates, and Conservation Measure VP-3, which states that if it is determined that areas within 250 feet of suitable vernal pool invertebrate habitat would be affected by implementation of the Proposed Action, a compensatory mitigation plan would be developed, in consultation with USFWS, to that will result in no net loss of acreage, function, and value of affected vernal pool habitat. Under Conservation Measure VP-3, unavoidable effects will be compensated through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. Therefore, potential adverse effects on Federally listed vernal pool invertebrates would be avoided or minimized.

Effects of Program-Level Actions. Vernal pool habitat is present along Reaches 1A, 4B, and 5 and the Eastside and Mariposa bypasses. Program-level actions that involve removing vegetation and disturbing the ground surface could result in direct removal or mortality of Federally listed vernal pool invertebrates, if they are present, or in removal or degradation of suitable habitat. These actions could include conducting construction activities along haul routes, in staging areas, and in project footprints and augmenting spawning gravels. Several indirect effects on vernal pool invertebrates have the potential to occur: changes in vegetation as a result of changes in management practices; altered hydrology from construction of new levees, haul roads, new or modified channels, or other program-level actions; fill of vernal pool habitats; habitat fragmentation; and the introduction or spread of invasive species during construction activities.

Vernal pools along Reach 1A are outside the Restoration Area; however, creating haul roads, staging areas, or other ancillary features adjacent to Reach 1A could result in loss or degradation of vernal pools. Program-level actions in Reach 4B and the Eastside and Mariposa bypasses, particularly channel modifications along the Eastside and Mariposa bypasses, could result in fill of vernal pools. Program-level actions would not affect vernal pools in Reach 5 because no ground-disturbing activities or actions that could result in fill of vernal pools would occur in this reach.

Conservation measures of the Conservation Strategy (Table 3-4) would be implemented to offset potential adverse effects on vernal pool invertebrates. Conservation Measure VP-1 requires the lead agencies to identify and map vernal pools and other seasonal wetland habitats potentially suitable for listed vernal pool invertebrates, and under Conservation Measure VP-2, a buffer would be established around the microwatershed of the habitat or a 250-foot buffer (whichever is greater), and worker awareness training and on-site biological monitoring would be conducted, to prevent impacts from vehicles and other construction equipment. Under Conservation Measure VP-3, unavoidable effects will be compensated through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. Therefore, potential adverse effects on Federally listed vernal pool invertebrates would be avoided and minimized.

Critical Habitat for Vernal Pool Invertebrates. Designated critical habitat for vernal pool fairy shrimp is located adjacent to but outside the Restoration Area in Reach 1A. In Reach 4B2 and in the Eastside and Mariposa bypasses, the Restoration Area includes critical habitat for Conservancy fairy shrimp (Units 7A–7D; 71 FR 7118), vernal pool fairy shrimp (Units 23A–23D; 71 FR 7118), and vernal pool tadpole shrimp (Units 16A–16D; 71 FR 7118). The Restoration Area in Reach 5 also includes designated critical habitat for Conservancy fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Critical habitat for longhorn fairy shrimp (Unit 2; 71 FR 7118) has been designated in the Restoration Area only in Reaches 4B2 and 5.

The primary constituent elements for these vernal pool invertebrates generally include (1) topographic features characterized by mounds, swales, or depressions in a matrix of surrounding uplands and (2) depressional features, including isolated vernal pools with underlying restrictive soil layers that are inundated during winter rains and that continuously hold water or whose soils are saturated for a temporary period.

Effects of Project-Level Actions. The maximum amount of critical habitat that could be affected by Interim and Restoration flows was calculated using the published ordinary high-water mark of the San Joaquin River and levee boundaries of the bypasses. The amount that could be affected represents a small fraction of the critical habitat designated for these species (Table 6-7). However, because these flows would largely be conveyed within the channel and would not inundate the full width of the levees, not all this acreage would be potentially affected.

Table 6-7.
Critical Habitat for Vernal Pool Invertebrates in Restoration Area

Species	Unit Number	Total Acres in Unit	Location	Maximum Acres Designated in Action Area[1]	Maximum Percent in Action Area
Conservancy fairy shrimp	7A	3,165	San Joaquin River Reaches 4B2 and 5	5	0.1
	7B	1,617	San Joaquin River Reach 4B2 and Eastside Bypass	33	2.1
	7C	6,030	San Joaquin River Reach 4B2 and Eastside and Mariposa bypasses	501	8.3
	7D	6,911	Eastside Bypass	9	0.1
Longhorn fairy shrimp	2	3,165	San Joaquin River Reaches 4B2 and 5	5	0.1
Vernal pool fairy shrimp	23A	3,165	San Joaquin River Reaches 4B2 and 5	5	0.1
	23B	1,617	San Joaquin River Reach 4B2 and Eastside Bypass	33	2.2
	23C	6,030	San Joaquin River Reach 4B2 and Eastside and Mariposa bypasses	501	8.3
	23D	6,911	Eastside Bypass	9	0.1
Vernal pool tadpole shrimp	16A	3,165	San Joaquin River Reaches 4B2 and 5	5	0.1
	16B	1,617	San Joaquin River Reach 4b2 and Eastside Bypass	35	2.2
	16C	6,030	San Joaquin River Reach 4B2 and Eastside and Mariposa bypasses	501	8.3
	16D	6,911	Eastside Bypass	9	0.1

Note:
[1] Based on the published ordinary high water mark of the San Joaquin, Tuolumne, Merced, and Stanislaus rivers and aerial photograph interpretation of levee boundaries of the Eastside and Mariposa bypasses. Because Interim and Restoration flows would not inundate this entire area, these calculations are overestimates of the potential acreage of critical habitat that could be affected. Furthermore, the low-flow channels of the rivers and bypasses are unlikely to contain the primary constituent elements of the designated critical habitats for the listed vernal pool invertebrates.

The Action Area is unlikely to contain the primary constituent elements for vernal pool invertebrates because vernal pools, swales, and other seasonal wetlands in an upland matrix are not found in the low-flow channel of riverine habitats or the bypasses. Vernal pool habitats are not expected to be substantially affected by implementing the Proposed Action because Interim and Restoration flows would largely be conveyed within the channel, and these channels are below grade; therefore, flows would be unlikely to extend to adjacent lands outside existing levees even in the case of seepage or levee failure. In addition, the project includes implementing a monitoring and management plan that would reduce long-term seepage-related effects on vernal pools and associated listed invertebrates outside the bypass levees. Because reoperation of Friant Dam would not affect any of the primary constituent elements of designated critical habitat for vernal pool invertebrates in Reaches 4B2 and 5, critical habitat for these species would not be adversely modified as a result of implementing the Proposed Action.

Although the Eastside and Mariposa bypass system is unlikely to contain vernal pool habitats, vernal pools may exist higher in the floodplain given the soil types and presence of vernal pools in the adjacent areas. If the primary constituent elements of designated critical habitats for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, or vernal pool tadpole shrimp are present in areas that would be subject to changes in hydrologic conditions related to Interim and Restoration flows, effects on designated critical habitat could occur.

Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations. Therefore, Federally designated critical habitat would not be adversely modified as a result of implementing the Proposed Action.

Effects of Program-Level Actions. Program-level actions in Reach 1A, such as construction and use of haul routes and staging areas for spawning-gravel augmentation or activities to fill or isolate gravel pits, could affect adjacent critical habitat for vernal pool fairy shrimp. In addition, designated critical habitat for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp, could be affected by program-level actions proposed for Reaches 4B2 and 5. Similar activities could occur in the Eastside and Mariposa bypasses and could affect designated critical habitats for these species. In addition, in the Eastside and Mariposa bypasses, structures may be modified to allow fish passage at a range of flows up to 4,500 cfs; a fish ladder may be constructed to allow upstream and downstream fish passage at a range of flows up to 4,500 cfs; and channel modifications may occur to allow fish passage under low flows. Construction of project footprints, haul routes, and staging areas could modify primary constituent elements for critical habitat in these areas.

Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations. The Proposed Action includes Conservation Measures VP-1 and VP-2 to avoid and minimize loss of vernal pool habitat. Conservation Measure VP-3 requires Reclamation to compensate for temporary or permanent loss of vernal pool habitat, using a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies. Under Conservation Measure VP-3, compensatory ratios for loss of habitat both in and out of core areas would be determined during coordination and consultation with USFWS and/or DFG, as appropriate, and in consideration of the Vernal Pool Recovery Plan goals for core areas. Therefore, Federally designated critical habitat would not be adversely modified as a result of implementing the Proposed Action.

Recovery Plan for Vernal Pool Invertebrates. Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp are all addressed in the Vernal Pool Recovery Plan (USFWS 2005). The entire Restoration Area, with the exception of Reach 1B, is encompassed in the vernal pool recovery units identified in the Vernal Pool Recovery Plan. Implementing the Proposed Action would not interfere with the recovery plan’s goals, objectives, strategies, or criteria. It would also not (1) substantially reduce the viability of target species, (2) reduce the habitat value or interfere with the management of conserved lands or recovery units, or (3) eliminate opportunities for conservation or recovery actions. Under Conservation Measure VP-3, part of the Proposed Action, effects and compensation for effects would be determined in consideration of the Vernal Pool Recovery Plan goals for core areas. Further, the Proposed Action would support the future enhancement and restoration of biological resources along the San Joaquin River. Therefore, implementing the Proposed Action would be unlikely to adversely affect recovery plans for vernal pool invertebrates.

Valley Elderberry Longhorn Beetle

In the long term, reoperation of Friant Dam is expected to result in a net increase in riparian and emergent wetland vegetation throughout the Restoration Area. Reoperation of the dam would increase the extent and duration of inundation, raise groundwater levels, and restore flows to reaches (e.g., Reaches 2B and 4B) that currently are not inundated by most seasonal flows and that are inundated by flood flows only periodically (every 2 years to 5 years) during winter, spring, or early summer (Jones and Stokes 2002; McBain and Trush 2002). Ultimately, reoperation of Friant Dam would have a beneficial effect on valley elderberry longhorn beetle. Conservation Measures VELB-1 and VELB-2 (Table 3-4) would preserve or enhance populations of elderberry shrubs (*Sambucus sp.*) by requiring biological monitoring of the elderberry population within site-specific project footprints, and requiring compensatory mitigation (which could include transplanting elderberry shrubs and/or additional elderberry and associated native plantings) for adverse effects that cannot be avoided.

In the short term, however, inundation, scour and sediment deposition along Reach 2 (upstream from the backwater of the Mendota Pool) resulting from Interim and Restoration flows could uproot, bury, or otherwise damage or kill elderberry shrubs. Conservation Measure VELB-2 (Table 3-4) would preserve or enhance habitat for valley elderberry longhorn beetle by requiring compensatory mitigation (which could include transplanting elderberry shrubs and/or additional elderberry and associated native plantings) for adverse effects that cannot be avoided.

Other potential actions could result in the disturbance or loss of habitat for this species during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities, particularly where such activities are conducted near riparian habitats.

However, with implementation of the Conservation Strategy (Table 3-4), the short-term adverse effects of the Proposed Action on valley elderberry longhorn beetle would be avoided or minimized.

Effects of Project-Level Actions. Elderberry shrubs (host to the Federally listed valley elderberry longhorn beetle) are associated with riparian habitats and typically are located on the higher portions of levees and stream banks, which are not subject to inundation or scour (Fremier and Talley 2009). Blue elderberry could be present along and above the immediate the shoreline of Millerton Lake. Reoperation of Friant Dam would not cause a substantial effect on this species because blue elderberry shrubs grow in woodland and riparian vegetation above the immediate shoreline of Millerton Lake.

Valley elderberry longhorn beetle may occur in other locations in the Restoration Area where its host plant is present. During 2004 and 2005, surveys for elderberry shrubs and evidence of valley elderberry longhorn beetle were conducted for 77 percent of the San Joaquin River between Friant Dam and the Merced River confluence (Endangered Species Recovery Program (ESRP) 2006). Kayak, ground, and aerial surveys were used to identify elderberry shrubs along the river corridor. Kayak and ground (i.e., road) surveys were able to detect shrubs within a 100 m range, but, in some areas, up to a 200 m range (ESRP 2004). Where elderberry shrubs were detected, the plant height was measured, stems measured and counted, and stems inspected for beetle exit holes (ESRP 2004). Aerial surveys were also conducted to identify flowering elderberry plants along the river course from the area of Gravelly Ford in Reach 2 to the confluence with the Merced River (ESRP 2004). Blue elderberry shrubs were found to be abundant along Reaches 1 and 2 of the San Joaquin River and were sparsely distributed along or absent from Reaches 3, 4, and 5 (ESRP 2006). Approximately 410 elderberry shrubs were mapped in Reaches 1 and 2. In Reaches 3, 4, and 5, three elderberry shrubs were observed from the air but could not be located during kayak or ground surveys.

Exit holes made by valley elderberry longhorn beetle larvae as they leave a host plant during metamorphosis to the adult stage were found in few shrubs throughout the Restoration Area; less than 1 percent of stems and less than 4 percent of shrubs observed had exit holes (ESRP 2006). Evidence of valley elderberry longhorn beetle was found to occur in 14 shrubs in Reach 1A and 2 shrubs in Reach 2, out of more than 400 shrubs examined (ESRP 2006).

These results indicated presence of valley elderberry longhorn beetle and its level of abundance, and potential distribution within the Restoration Area, but are not an inventory of its current distribution. First, within several years, elderberry shrub and exit hole surveys become increasingly outdated: elderberry shrubs grow rapidly and may have established and grown in surveyed areas since the surveys were conducted. Second, elderberry shrubs may exist in areas that have not been surveyed, and within surveyed areas, exit-hole surveys were not comprehensive.

These survey results did not record the distribution of shrubs with exit holes with respect to the river channel. However, valley elderberry longhorn beetle distribution may be related to elevation along the San Joaquin River. In a study along the Cosumnes River, the density of valley elderberry longhorn beetle exit holes was negatively correlated with higher relative bank position (Fremier and Talley 2009). That is, the beetles are more likely to be found in shrubs closer to the river. Although many environmental variables may affect the distribution of valley elderberry longhorn beetle (Fremier and Talley 2009), proximity to river flows and association with riparian communities are important factors that contribute to the species' presence (Talley, pers. comm., 2009).

Recognizing that these surveys were not exhaustive, additional surveys are being conducted, and will continue to be coordinated with USFWS. In 2009, Reclamation conducted additional kayak surveys along the first 35 miles of Reach 1, beginning at Friant Dam. Although these surveys did not measure any shrubs, the surveys were able to characterize the location of the shrubs. For example, most elderberry shrubs were found on the upper river banks and the majority of shrubs were located in Reach 1B. The results of these surveys were correlated with aerial surveys that were conducted by Reclamation during the elderberry flowering period along this same river course in 2010.

Most elderberry shrubs in the Restoration Area are not anticipated to be inundated by Interim and Restoration flows because of their locations higher on the streambanks. However, some elderberry shrubs were noted to be growing along the channel in Reach 2A (ESRP 2004, 2006), likely a result of altered channel formation and limited flows: except during times of floods, water passing Gravelly Ford (head of Reach 2A) typically infiltrates the sandy bed before reaching the Chowchilla Bypass Bifurcation Structure (end of Reach 2A).

Interim and Restoration flows are expected to submerge the shoots and leaves of existing riparian and wetland plants for weeks or months during each growing season, which for many plants may damage some plant parts or reduce growth. However, riparian plants generally can adjust to conditions of periodic inundation.

As described above, most elderberry shrubs are not expected to be growing in low-flow channels or in areas that are currently subject to scouring flows. This distribution would partly be the result of elderberry shrubs being relatively inefficient at adapting to prolonged flood inundation compared with other riparian plants, such as willow (Fremier and Talley 2009).

The few elderberry shrubs in Reach 2 that are growing along the river channel or lower floodplain surfaces may be partially inundated during a period in spring (up to a maximum of 1,370 cfs to 1,470 cfs). The period of these higher maximum flows would be from mid-March through June, which corresponds to the natural hydrograph of rivers that receive snowmelt from the Sierra Nevada. Under existing conditions, elderberry shrubs in Reach 2 are subject to temporary flood flows that occur every 2 to 5 years. Thus, these shrubs can withstand periodic inundation; Interim and Restoration flows would not be likely to result in loss of elderberry shrubs.

It is uncertain how valley elderberry longhorn beetles would respond to inundation of elderberry host plants for a maximum period of up to 14 weeks, from mid-March to the end of June (Talley, pers. comm. 2009). Valley elderberry longhorn beetle larvae use the pith of elderberry stems, a very low-nutrient (and probably a low-oxygen) environment, as a growth chamber from mid-March to June, when adults emerge to feed and reproduce on leaves and flowers of the elderberry shrub. Thus, inundating the lower portions of the elderberry plant, if the plant is not damaged or taken, is not likely to adversely affect beetle larvae, if they are present (Talley, pers. comm. 2009).

Interim and Restoration flows are not likely to result in a measurable direct effect on valley elderberry longhorn beetle because (1) most habitat for the species is outside the area that would be inundated by the flows, (2) the flows would not be of a magnitude sufficient to result in scouring or deposition of sediment that could damage elderberry shrubs potentially containing valley elderberry longhorn beetle larvae or pupae, and (3) any larvae or pupae present in shrubs that could be temporarily inundated would likely be able to withstand conditions because they are adapted to riparian habitats that are subject to periodic inundation.

Elderberry shrubs in Reach 1 are concentrated outside the channel and would not be expected to be affected by flow changes. However, in Reach 2A, where elderberry shrubs may be growing at low elevations along portions of the channel that under existing conditions do not receive regular flows, implementing Interim and Restoration flows could result in damage or physiological stress to elderberry shrubs that may contain valley elderberry longhorn beetle. Therefore, the Proposed Action includes measures to avoid, minimize, and/or compensate for these effects. Conservation Measure VELB-1 (Table 3-4) would avoid and minimize effects to this species by surveying for shrubs in the Action Area and establishing buffers around these shrubs to prevent ground-disturbing activities from occurring within 100 feet of the shrubs. Conservation Measure VELB-1 also includes conducting worker environmental awareness training and biological monitoring to ensure that avoidance measures are being implemented. Conservation Measure VELB-2 (Table 3-4) would preserve or enhance habitat for valley elderberry longhorn beetle by requiring compensatory mitigation (which could include transplanting elderberry shrubs and/or additional elderberry and associated native plantings) for adverse effects that cannot be avoided. Therefore, potential adverse effects on this species would be avoided or minimized.

Effects of Program-Level Actions. Valley elderberry longhorn beetle is known to occur in Reaches 1A and 2, and elderberry shrubs (potential habitat) are widespread along the San Joaquin River, especially in Reaches 1 and 2. Potential construction sites are anticipated to have footprints that would be within these reaches, but which would not span the entire area of these reaches. However, habitat (i.e., elderberry shrubs) could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities, particularly where such activities are conducted near riparian habitats. Therefore, implementation of the program-level actions could result in adverse effects on this species.

Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Conservation Measure VELB-1 (Table 3-4) would avoid and minimize effects to this species by surveying for shrubs in the Action Area and establishing buffers around these shrubs to prevent ground-disturbing activities from occurring within 100 feet of the shrubs. Conservation Measure VELB-1 also includes conducting worker environmental awareness training and biological monitoring to ensure that avoidance measures are being implemented. Conservation Measure VELB-2 (Table 3-4) would preserve or enhance habitat for valley elderberry longhorn beetle by requiring compensatory mitigation (which could include transplanting elderberry shrubs and/or additional elderberry and associated native plantings) for adverse effects that cannot be avoided. These conservation measures would be implemented during the subsequent site-specific project studies, and the extent of surveys and number of transplants would be based on the location and extent of the site-specific action. Each site-specific project would have a smaller footprint for which surveys and transplanting would be conducted, in compliance with the conservation measures, prior to construction.

Critical Habitat for Valley Elderberry Longhorn Beetle. Critical habitat for valley elderberry longhorn beetle does not occur in the Action Area; therefore, none would be adversely affected by the Proposed Action.

Recovery Plan for Valley Elderberry Longhorn Beetle. USFWS recently completed a 5-year status review for valley elderberry longhorn beetle and recommended delisting the species because of comprehensive riparian habitat restoration projects throughout the range of the species and because surveys have documented that the species is more widespread than was thought at the time of listing (USFWS 2006a). At the time of listing, the primary threats to the species were identified as (1) loss of riparian habitat because of flood control, agricultural, and park management practices and (2) lack of adequate regulatory mechanisms to protect the species. Surveys have documented valley elderberry longhorn beetle at more than190 locations throughout its range, from Shasta County to Fresno County. Loss of riparian habitat has slowed in the Central Valley, and a number of programs are in place to help protect and restore valley elderberry longhorn beetle (e.g., HCPs, habitat restoration projects on Federal, State, and private lands). Efforts specific to valley elderberry longhorn beetle have resulted in the protection of more than 50,000 acres of riparian habitat and the restoration of approximately 5,100 acres of beetle habitat (USFWS 2006a).

California Tiger Salamander

Although the Proposed Action would not measurably or directly affect suitable habitat for California tiger salamander, implementing Conservation Measures CTS-1, CTS-2, and CTS-3 would avoid, minimize, and compensate for potential effects on this species.

Effects of Project-Level Actions. California tiger salamander uses vernal pools and seasonal wetlands for breeding and upland grassland habitats for dispersal, foraging, and refuge. This species is not expected to occur in the San Joaquin River corridor; however, suitable wetland habitat (e.g., vernal pools and seasonal wetlands) may exist in the Eastside and Mariposa bypasses, outside the channels and lower floodplain terraces. California tiger salamanders are known to occur north of the Eastside Bypass in the Merced NWR in floodplain wetlands, slough channels, vernal pools, and artificially created pools adjacent to levees and roads (CNDDB 2011). Regularly inundating these habitats may make seasonal pools unsuitable by altering their hydrology or by increasing predation from nonnative fish or bullfrogs, which require more permanent water. If California tiger salamander is present in seasonal wetland habitats in the bypasses, implementing Interim and Restoration flows at magnitudes that would exceed the existing channels could result in loss of habitat or individuals.

As stated previously for vernal pool plants and invertebrates, the presence of vernal pools or seasonal wetland habitat in the Eastside and Mariposa bypasses has not been confirmed, but these habitats are unlikely to exist in the channel and lower floodplain terraces. In the bypasses, Interim and Restoration flows would largely be conveyed through the channel and would not inundate vernal pools or other floodplain habitat that could contain seasonal wetlands. However, because habitat mapping has not been completed in these areas, and vernal pools are known to occur, or have occurred historically, outside the bypass levees in adjacent lands, vernal pools or other seasonal wetland habitats may be present on existing levees. Interim and Restoration flows could increase the extent, duration, or frequency of inundation in these habitats, and Federally listed vernal pool plants could be adversely affected if these habitats are inundated too long during the growing season for the plants to complete their life cycles. Implementing the Proposed Action would also not likely have an adverse effect on upland habitat for California tiger salamander. This species is not likely to use the channel and lower floodplain terraces for upland aestivation or foraging habitat. The presence of water seasonally in the bypass may restrict dispersal of California tiger salamanders under baseline conditions, and the Proposed Action would not substantially change these conditions. Therefore, flows would not have a measurable direct effect on aquatic habitat for California tiger salamander.

Effects of Program-Level Actions. California tiger salamander is not expected to occur in the San Joaquin River corridor but may occur in uplands adjacent to the river or bypasses. Aquatic breeding, upland forage, refuge, and dispersal habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Ground disturbance could result in direct loss of habitats or indirectly result in elimination of areas essential for seasonal movement.

However, California tiger salamander conservation measures have been incorporated into the conservation strategy to avoid, minimize, and compensate for adverse effects on this species (Table 3-4). These measures include identifying and mapping potential California tiger salamander habitat within the project footprint and avoiding and minimizing project effects to the extent feasible (Conservation Measures CTS-1 and CTS-2). Conservation Measure CTS-3 requires that a compensatory mitigation plan be developed and implemented in coordination with USFWS and DFG (as appropriate). Unavoidable effects would be compensated under this plan through a combination of creation, preservation, and restoration of habitat or purchase of credits at a mitigation bank approved by the regulatory agencies

Critical Habitat for California Tiger Salamander. Critical habitat for California tiger salamander has been designated on alluvial terraces adjacent to Reach 1A of the San Joaquin River (Unit 1B). Of the 3,003 acres in the unit, 19 acres of critical habitat (0.6 percent of the unit) extend into the river corridor along the north bank of the river. Given that release of Interim and Restoration flows would be confined to the river channel and that riverine habitats are generally unsuitable for California tiger salamander, implementing the Proposed Action is not expected to affect any of the primary constituent elements of critical habitat for this species. Therefore, implementing the Proposed Action would not adversely affect critical habitat for California tiger salamander.

Program-level actions in Reach 1A, such as construction and use of haul routes and staging areas for spawning gravel augmentation or activities to fill or isolate gravel pits, could affect critical habitat for California tiger salamander. Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations.

Under Conservation Measures VP-1 and VP-2, potential habitat for listed vernal pool plant species would be mapped and this habitat, plus a 250-foot buffer, would be avoided during construction activities to the extent feasible. Under Conservation Measure VP-3, any loss of occupied habitat that could not feasibly be avoided would be compensated for through a combination of creation, preservation, and restoration of vernal pool habitat or purchase of credits at a mitigation bank approved by the applicable regulatory agency/agencies, as appropriate. Similarly, under Conservation Measure CTS-1, habitat potentially suitable for California tiger salamander would be identified and mapped and where burrow complexes are present, a 250-foot-wide buffer would be placed to avoid or minimize disturbance to the species. Conservation Measure CTS-2 requires the use of exclusion fencing and biological monitoring on construction sites, restricts the use of monofilament or similar material and construction hours, and requires revegetation of project areas to minimize effects to California tiger salamander. Finally, under Conservation Measure CTS-3, a compensatory conservation plan would be developed and implemented in coordination with USFWS and DFG, and unavoidable effects to

Federally designated critical habitat would be compensated through a combination of creation, preservation, and restoration of habitat or purchase of credits at a mitigation bank approved by the regulatory agencies.

Recovery Plan for California Tiger Salamander. A recovery plan for California tiger salamander has not been developed, and recovery goals for this species have not been identified in other recovery plans.

Blunt-Nosed Leopard Lizard

Although the Eastside and Mariposa bypasses are periodically inundated by flood flows, which likely reduces the suitability of habitat for blunt-nosed leopard lizards in these areas, this species could be adversely affected by implementing the Proposed Action. Implementing the Conservation Strategy (Table 3-4) would avoid and minimize adverse effects on this species by identifying and avoiding suitable habitat.

Effects of Project-Level Actions. The blunt-nosed leopard lizard is associated with alkali scrub habitat or other sparsely vegetated habitats with sandy soils. Blunt-nosed leopard lizards use the burrows of small rodents for shelter, predator avoidance, and behavioral thermoregulation. Three areas have been identified as having potential blunt-nosed leopard lizard habitat based on aerial maps. These areas include approximately 2,460 acres along the southwest side of the San Joaquin River in Reach 2, approximately 490 acres in a portion of the Eastside Bypass and adjacent lands near Reach 4A of the San Joaquin River, and approximately 2,938 acres encompassing the northern side of the Mariposa Bypass and parcels north of the Mariposa Bypass and west of the Eastside Bypass.

Under baseline conditions, the Eastside and Mariposa bypasses are periodically inundated by flood flows, which likely reduce the suitability of habitat for blunt-nosed leopard lizards in these areas. However, because flood flows occur seasonally and vary in magnitude between years, blunt-nosed leopard lizard might be present in areas that would be inundated by Interim and Restoration flows if individuals from existing populations outside of the levees moved into the channel when conditions are dry. If present, some individuals might be unable to escape rising flow waters during spring.

Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Under Conservation Measure BNLL-1, within 1 year before the commencement of the proposed project, focused site visits and habitat assessment would be conducted on these lands. Based on focused assessment, and discussions with USFWS and DFG, protocol-level surveys could be conducted. If blunt-nosed leopard lizards are detected within or adjacent to the project site, measures that would avoid direct take of this species would be developed in cooperation with USFWS and DFG and implemented before ground disturbing activities (DWR 2010). Therefore, potential adverse effects on this species would be avoided and minimized.

Effects of Program-Level Actions. Blunt-nosed leopard lizard habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Under Conservation Measure BNLL-1, if blunt-nosed leopard lizards are detected within or adjacent to the project site, measures that would avoid direct take of this species would be developed in cooperation with USFWS and DFG and implemented before ground-disturbing activities (DWR 2010); therefore, adverse effects would be avoided and minimized.

Critical Habitat for Blunt-Nosed Leopard Lizard. No critical habitat for blunt-nosed leopard lizard has been designated; therefore, implementing the Proposed Action would not adversely affect critical habitat for this species.

Recovery Plan for Blunt-Nosed Leopard Lizard. Recovery goals for the blunt-nosed leopard lizard are identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). A 5-year status review for blunt-nosed leopard lizard was completed in 2010, and no change in its status was recommended (USFWS 2010). Implementing the Proposed Action would be unlikely to have an adverse effect on recovery goals for blunt-nosed leopard lizard because the Proposed Action would not affect an area containing important habitat for the species.

Giant Garter Snake

Interim and Restoration flows would increase the volume and availability of water in the San Joaquin River channel between early spring and midsummer, which is the active period for this species. Because the giant garter snake requires aquatic habitat for breeding and foraging during spring and summer, the presence of additional flows during these seasons would have a beneficial effect on this species by increasing the availability and reliability of aquatic habitats. Although the increase in water flow could increase water velocities in the river channel, direct effects on giant garter snake are expected to be negligible because the snakes are typically absent from larger rivers and other bodies of water (Hansen and Brode 1980), such as the main channel (Reaches 1 through 5), which does not provide suitable aquatic habitat for this species, with the exception of the Mendota Pool at the head of Reach 3. In the Mendota Pool, velocity would not be substantially altered because although the pool and river are hydraulically connected, most of the pool lies outside the route of Interim and Restoration flows. Furthermore, velocities in the pool’s backwater on the San Joaquin River would not increase substantially because of the pool’s width and volume. With implementation of the Conservation Strategy (Table 3-4), any potential adverse effects of the Proposed Action on this species would be avoided or minimized.

Effects of Project-Level Actions. The giant garter snake is known to occur in suitable habitat in the San Luis NWR Complex, in the Mendota Wildlife Area, at Mendota Pool (Dickert 2005), and south of the San Joaquin River in Fresno Slough (USFWS 2006b). Although no sightings of giant garter snakes south of the Mendota Wildlife Area have occurred since the time of listing (Hansen 2002), the species is expected to occur in suitable habitat at other locations in the Restoration Area and, although it generally avoids large, wide rivers, giant garter snakes may occur in portions of the river channel that would be inundated by the release of Interim and Restoration flows. This species also may occur in suitable habitat in other locations in the Action Area.

This species requires aquatic habitat for breeding and foraging during spring and summer. Therefore, the presence of additional flows during these seasons, as well as in winter, would have a beneficial effect on this species. Although water velocities would increase in the Mendota Pool between the San Joaquin River and Mendota Dam during Interim and Restoration flows, velocity would not be substantially altered because although the pool is hydraulically connected to the river, most of the pool lies outside of the primary route of Interim and Restoration flows. Furthermore, because of the pool's width and volume, velocities in the pool's backwater on the San Joaquin River would not increase substantially.

Effects on upland habitats that this species uses for refuge are not expected from Friant Dam reoperation. Flows generally would be restricted to the river channel and immediately adjacent, lower floodplain surfaces and would not inundate a substantial amount of available upland habitat. Therefore, implementing the Proposed Action would not adversely affect this species.

Effects of Program-Level Actions. Giant garter snake is known to occur in the Mendota Pool. Aquatic habitat could be affected during instream work to increase channel capacity, supplement spawning gravel, fill gravel pits, modify side channels, and install fish screens or make other modifications to diversion structures. Upland nesting and aestivation habitat could be disturbed or lost during construction of setback levees, bypass structures, haul and access roads, and staging areas; modification of channels in the bypass system; or other ground-disturbing activities. Thus, implementing the Proposed Action could adversely affect this species. As summarized in Table 3-4, Conservation Measures GGS-1 and GGS-2 would be implemented to avoid and minimize effects on this species, including conducting preconstruction surveys and compensating for temporary and permanent effects on its habitat.

Critical Habitat for Giant Garter Snake. Critical habitat has not been designated for giant garter snake; therefore, none would be adversely affected as a result of implementing the Proposed Action.

Recovery Plan for Giant Garter Snake. Recovery goals for the giant garter snake are identified in the *Draft Recovery Plan for the Giant Garter Snake (Thamnophis gigas)* (USFWS 1999c). The Restoration Area is located in the San Joaquin Valley Recovery Unit, as described in the draft recovery plan. Implementing the Proposed Action would be unlikely to have a substantial effect, and may have a slight beneficial effect, on recovery goals for giant garter snake because suitable upland habitats would not be affected by Interim and Restoration flows, and its aquatic habitat would expand.

Western Yellow-Billed Cuckoo

Because Interim and Restoration flows would generally be at nearly their highest levels by March 16, before the nesting season of western yellow-billed cuckoo, implementing project-level actions would not adversely affect this species. Implementing the Conservation Strategy (Table 3-4) would offset potential effects of program-level actions by enhancing and expanding riparian habitats in this species' range.

Effects of Project-Level Actions. Most recent records of the western yellow-billed cuckoo are in the Sacramento Valley (Gaines and Laymon 1984). An area near the confluence of the Tuolumne and San Joaquin rivers where a few cuckoos were observed regularly in the late 1960s was subsequently subject to intensive logging, and no cuckoos have been observed in recent years (Reeve, pers. comm., 1998, cited in McBain and Trush 2002). The yellow-billed cuckoo has been considered a rare migratory species during spring in Stanislaus County (Reeve 1988). This species has potential to nest in suitable habitat in the Restoration Area. It also may occur in suitable habitat in other locations in the Action Area, including along portions of the San Joaquin River channel that would be inundated by the release of Interim and Restoration flows.

Western yellow-billed cuckoo builds nests in large trees or shrubs that would be well above the waterline under the Proposed Action during the breeding season (approximately mid-June through mid-August). Interim and Restoration flows would not substantially inundate upland foraging areas for this species; therefore, the reoperation of Friant Dam is not expected to adversely affect this species.

The nests of western yellow-billed cuckoos would be expected to be well above the waterline during the breeding season (approximately mid-June through mid-August). Interim and Restoration flows could progressively increase nonflood flows during February, March, April, and May throughout the Restoration Area. The potential exists for increased flows to inundate nest sites if they are established before releases, which would result in nest abandonment and the loss of any viable eggs or chicks that have not yet fledged. However, these areas already experience periodic flood flows during spring, and Interim Flows would generally be at nearly their highest levels by March 16, before the nesting season of the western yellow-billed cuckoo. Western yellow-billed cuckoos would migrate into the Restoration Area or downstream along the San Joaquin River from late May until late June and would naturally construct their nests above the levels of Interim Flows. Furthermore, the number of nests established below the levels of Interim and Restoration flows during the breeding season is expected to be low, given the prevalence of surrounding habitats that are suitable. Therefore, implementing the Proposed Action would not result in any measurable or detectable adverse direct effects on the western yellow-billed cuckoo.

Effects of Program-Level Actions. Yellow-billed cuckoo nest sites are associated with large and wide patches of riparian habitat (Laymon and Halterman 1989). In the western United States, yellow-billed cuckoos breed in broad, well-developed, low-elevation riparian woodlands composed primarily of mature cottonwoods (*Populus spp*.) and willows (*Salix spp*.). They have also been observed nesting in orchards adjacent to riparian habitats (Gaines and Laymon 1984). Although nesting western yellow-billed cuckoos are rare throughout the river corridor, disturbance from construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities could result in loss of trees and shrubs occupied by nesting birds if construction occurs during the breeding season. Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Conservation Measure MBTA-1 (Table 3-4) would avoid and minimize effects on nesting birds, including western yellow-billed cuckoo, by requiring that Proposed

Action activities would not occur during from February 1 to September 1, if covered under the Migratory Bird Treaty Act and Fish and Game Code Sections 3503, 3503.5, and 3513 are determined to be present. Further, implementation of Conservation Measures RHSNC-1 and RHSNC-2 would avoid or minimize the loss of riparian and other sensitive natural communities, and would provide for no net loss of habitat function or acreage of these communities. Therefore, implementing the Proposed Action would not adversely affect the western yellow-billed cuckoo.

Critical Habitat for Western Yellow-Billed Cuckoo. Critical habitat has not been designated for western yellow-billed cuckoo; therefore, none would be adversely modified as a result of implementing the Proposed Action.

Recovery Plan for Western Yellow-Billed Cuckoo. A recovery plan for western yellow-billed cuckoo has not been developed, and recovery goals for this species have not been identified in other recovery plans.

Least Bell's Vireo

Because Interim and Restoration flows would generally be at nearly their highest levels by March 16, before the nesting season of least Bell's vireo, implementing project-level actions would not adversely affect this species. Implementing the Conservation Strategy (Table 3-4) would offset potential effects of the program-level actions by avoiding construction activities during the nesting season (MBTA-1) and by enhancing and potentially expanding riparian habitats in this species' range (RHSNC-1 and RHSNC-2).

Effects of Project-Level Actions. By 1980, least Bell's vireo was extirpated from the entire Central Valley, although the species' range is currently expanding northward (RHJV 2004); it successfully nested at the San Joaquin River NWR in 2005 and 2006 (USFWS 2006c). The least Bell's vireo nests in dense, low, shrubby vegetation, generally in riparian areas but also brushy fields, young second-growth forest or woodland, scrub oak, coastal chaparral, and mesquite brushlands, where it may build nests as low as 1 foot above the ground. This species may occur in suitable habitat in the Action Area, including along portions of the San Joaquin River channel that would be inundated by the release of Interim and Restoration flows.

Implementing the Proposed Action could progressively increase nonflood flows in February, March, April, and May throughout the Restoration Area. The potential exists for increased flows to inundate nest sites of ground and low-vegetation nesters, including least Bell's vireo, if they are established before releases. This would result in nest abandonment and the loss of viable eggs or chicks that have not yet fledged.

Existing habitat types in these channel reaches have potential to support these species; however, these areas already experience periodic flood flows during spring, and Interim and Restoration flows would generally be at nearly their highest levels by March 16, before the nesting season of most birds, such as migratory passerines like the least Bell's vireo. Least Bell's vireos would migrate into the Restoration Area or downstream along the San Joaquin River in mid-April to late April and would construct their nests above the levels of Interim and Restoration flows. Furthermore, the incidence of nests established below the levels of Interim and Restoration flows during the breeding season is expected to be low, given the prevalence of surrounding habitats that are suitable. Therefore, implementing the Proposed Action would be unlikely to adversely affect least Bell's vireo.

Effects of Program-Level Actions. Least Bell's vireo nests in riparian scrub and woodlands. It was rediscovered nesting at the San Joaquin River NWR in 2006, but it may occur in the Restoration Area. If construction occurs during the breeding season, low- and ground-nesting birds, such as least Bell's vireo, could be lost because of disturbance during construction of setback levees, bypass structures, haul and access roads, and staging areas; augmentation of spawning gravels; or other ground-disturbing activities. Conservation Measure1 MBTA-1 (Table 3-4) would avoid and minimize effects on nesting birds, including least Bell's vireo, by requiring that Proposed Action activities would not occur during the typical breeding season. Further, implementation of Conservation Measures RHSNC-1 and RHSNC-2 would avoid or minimize the loss of riparian and other sensitive natural communities, and would provide for no net loss of habitat function or acreage of these communities.

Critical Habitat for Least Bell's Vireo. Critical habitat has been designated for least Bell's vireo; however, because the critical habitat is not located in the Action Area, none would be adversely affected as a result of implementing the Proposed Action.

Recovery Plan for Least Bell's Vireo. A draft recovery plan for least Bell's vireo has been prepared (USFWS 1998b). The plan does not identify recovery goals specific to the Action Area. However, it does identify a goal of protecting and managing riparian habitats in the species' historical range. Implementing the Proposed Action may increase riparian habitats in this species' range, thus contributing to a potential beneficial effect.

Fresno Kangaroo Rat

Because of the limited distribution of the Fresno kangaroo rat in the Restoration Area and because Interim and Restoration flows would be restricted to the river channel and lower floodplain surfaces, this species would not be adversely affected by implementing project-level actions. Although this species is unlikely to occur in areas where program-level actions would be implemented, Conservation Measures FKR-1, FKR-2, and FKR-3 would avoid, minimize, and compensate (if needed) for impacts to this species, while providing for avoidance of primary constituent elements of designated critical habitat; therefore, the Proposed Action is not likely to adversely affect Fresno kangaroo rat or its Federally designated habitat.

Effects of Project-Level Actions. Fresno kangaroo rat is a small burrowing mammal that has been reported in the vicinity of the Restoration Area, having been observed at the Alkali Sink Ecological Reserve and Mendota Wildlife Area. This species is considered by some to be extirpated along the San Joaquin River because of repeated negative findings during survey efforts since 1993 (DFG 2005). This species inhabits grassland and scrub habitats but does not occupy riparian areas, although it may disperse through dry river washes. It tends to have small home ranges and is not expected to regularly disperse across the river channel. Suitable upland habitats and occupied burrows may be located adjacent to the Restoration Area; however, this species would not be adversely affected along any reach or bypass because Interim and Restoration flows would be restricted to the river channel and lower floodplain surfaces.

Effects of Program-Level Actions. Recent trapping surveys have not detected the Fresno kangaroo rat along the San Joaquin River (ESRP 2004; DFG 2005). Populations may still occur at the Alkali Sink Ecological Reserve and the Mendota Wildlife Area or other private lands where suitable habitat could exist. Construction activities and facility modifications are unlikely to affect known populations but could affect habitat on private land adjacent to Reach 2B that has not been surveyed. The Conservation Strategy includes a conservation measure (FKR-1) to avoid and minimize potential adverse effects on this species that may result from implementing program-level actions; Conservation Measure FKR-1 requires preconstruction surveys for this species and restriction of construction activities to outside the breeding season for this species. Under Conservation Measure FKR-2, facility construction and modification and other restoration projects would be sited to avoid primary constituent elements of designated critical habitat for Fresno kangaroo rat, while under Conservation Measure FKR-3, compensation for impacts to Fresno kangaroo rat would be determined in coordination with DFG and USFWS, as appropriate.

Critical Habitat for Fresno Kangaroo Rat. Critical habitat has been designated for Fresno kangaroo rat, adjacent to the Restoration Area, approximately 4 miles from the Restoration Area in Reaches 2A and 2B. However, because this critical habitat is not located in the Action Area, none would be adversely modified as a result of implementing the Proposed Action.

Program-level actions proposed in Reach 2 include constructing a bypass around Mendota Pool to convey at least 4,500 cfs from Reach 2B to Reach 3 downstream from Mendota Dam. This action also involves constructing a bifurcation structure in Reach 2B to convey at least 4,500 cfs to the Mendota Pool Bypass. The bifurcation structure would be designed to divert up to 2,500 cfs to Mendota Pool, consistent with the design channel capacity of Reach 2B. Constructing the bypass and bifurcation structure could affect the primary constituent elements of designated critical habitat for Fresno kangaroo rat, depending on where the project footprint and the staging and access areas are located. Therefore, project footprints, haul routes, and staging areas could affect primary constituent elements of critical habitat designated in the vicinity of Reaches 2A and 2B.

Conservation measures would avoid, minimize, and/or mitigate for these potential effects. Implementing the critical habitat and Fresno kangaroo rat conservation measures of the Conservation Strategy (Table 3-4) would offset potential adverse effects on critical habitat. Conservation Measure FKR-2 requires that facility construction and modification and other restoration projects be sited to completely avoid designated critical habitat for Fresno kangaroo rat, which is located approximately 4 miles away from the Restoration Area. Conservation Measure CH-1 requires the lead agencies to identify and map Federally designated critical habitat and to design projects to avoid adverse modifications to these areas or, if avoidance is not feasible, implement measures to minimize adverse modifications. Under Conservation Measure CH-2, compensatory conservation measures developed through Section 7 consultation with USFWS would be implemented for any unavoidable effects on Federally designated critical habitat for the preservation of long-term viable populations. Conservation Measure FKR-3 requires compensation for temporary and permanent losses of habitat for this species.

Recovery Plan for Fresno Kangaroo Rat. Recovery goals for Fresno kangaroo rat are identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). This plan relies, in part, on additional preservation, restoration, and enhancement of habitat to achieve its goals. Consistent with this goal, the Proposed Action includes Conservation Measure FKR-2, which would require actions be sited so as to avoid primary constituent elements of designated critical habitat. Obtaining additional information on the distribution and abundance of Fresno kangaroo rats is also a component of the recovery strategy; Conservation Measure FKR-1 requires preconstruction surveys for this species and, if burrows are found within 100 feet of the project area, focused live trapping surveys would be required. These measures would contribute to the goals of the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). Therefore, the Proposed Action would be unlikely to have a substantial effect on recovery goals for Fresno kangaroo rat.

Riparian (San Joaquin Valley) Woodrat

Based on the reduced population of this species, and the diminished effects of flows on riparian communities below the confluence of the Merced River, project-level actions would be unlikely to adversely affect the riparian woodrat. Because the Proposed Action could expand available riparian habitats in the historical range of this species, the Proposed Action could have a beneficial effect on the riparian woodrat.

Effects of Project-Level Actions. The riparian woodrat has not been documented in the Restoration Area or its vicinity. This species builds stick houses in dense riparian vegetation at the base of trees or in tree cavities and canopies. Potentially suitable habitat is present in riparian vegetation that would be inundated by Interim and Restoration flows. The only verified extant population of this species is located on the Stanislaus River at Caswell Memorial State Park; however, the effect of implementing Interim and Restoration flows on water surface elevations would be greatly diminished below the confluence of the Merced River. Because the timing of increased flows would be similar to historical flood flows and would be confined to existing channels, existing riparian vegetation would not be greatly affected below the confluence of the Merced River. Therefore, implementing the Proposed Action would not result in adverse effects on riparian woodrat.

Effects of Program-Level Actions. Although the distribution of this species is not well known and the riparian woodrat is not known to occur in the Restoration Area, potentially suitable habitat is present. Riparian woodrat populations are greatly reduced, with the only known population at Caswell Memorial State Park. A second population may be located near Vernalis, downstream from the Restoration Area. Implementation of Conservation Measures RHSNC-1 and RHSNC-2 would avoid or minimize the loss of riparian and other sensitive natural communities, and would provide for no net loss of habitat function or acreage of these communities. Program-level actions could result in beneficial effects on this species by conserving or expanding available riparian habits in its historical range.

Critical Habitat for Riparian (San Joaquin Valley) Woodrat. Critical habitat has not been designated for riparian woodrat; therefore, none would be adversely affected as a result of implementing the Proposed Action.

Recovery Plan for Riparian (San Joaquin Valley) Woodrat. Recovery goals for the riparian woodrat are identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California* (USFWS 1998a). Implementing the Proposed Action would be unlikely to have a substantial effect on recovery goals for riparian woodrat, although it could expand suitable habitat for this species in its historic range.

Riparian Brush Rabbit

Because of the riparian brush rabbit's limited distribution and because this species is not expected to occur upstream from the confluence with the Merced River (where some detectable effects of Interim and Restoration flows may occur), implementing the Proposed Action would not adversely affect this species. Further, the Proposed Action would occur outside this species' extant range.

Effects of Project-Level Actions. The riparian brush rabbit has limited distribution along the lower portions of the San Joaquin and Stanislaus rivers. Recent captive breeding and recovery efforts have included establishing one population in 2002 in restored habitat on the San Joaquin River NWR and releasing another small population in 2005 on private lands adjacent to the San Joaquin River NWR, west of Modesto. Other populations are known from Caswell Memorial State Park near Ripon and from Paradise Cut and the San Joaquin River west of Manteca. Riparian brush rabbit is not expected to occur upstream from the confluence of the San Joaquin River with the Merced River. As described in Chapter 11.0, "Hydrology – Flood Management," of the Draft PEIS/R, the change in maximum flow and water surface elevation on the San Joaquin River downstream from the Merced River confluence would be negligible. Because the Interim and Restoration flows would result in negligible changes in surface water elevation, existing riparian vegetation would not be greatly affected below the confluence of the Merced River. Therefore, implementing the Proposed Action would not result in any measurable or detectable adverse direct or indirect effects on the riparian brush rabbit.

Effects of Program-Level Actions. Riparian brush rabbit is known to occur only in limited areas near the San Joaquin River NWR, downstream from proposed construction activities. It is unlikely to occur in the Restoration Area; therefore, program-level actions would not adversely affect this species.

Critical Habitat for Riparian Brush Rabbit. Critical habitat has not been designated for riparian brush rabbit; therefore, none would be adversely affected as a result of implementing the Proposed Action.

Recovery Plan for Riparian Brush Rabbit. Recovery goals for the riparian brush rabbit are identified in the *Recovery Plan for Upland Species of the San Joaquin Valley,* *California* (USFWS 1998a). Implementing the Proposed Action may have a beneficial effect on recovery goals for riparian brush rabbit because riparian habitats are expected to increase in the Restoration Area, expanding habitat potentially suitable for this species.

San Joaquin Kit Fox

Because Interim and Restoration flows would not affect denning or foraging behaviors and opportunities for San Joaquin kit fox, implementing project-level actions would not result in direct adverse effects on this species. Although the program-level actions could adversely affect this species, implementation of measures in the Conservation Strategy (Table 3-4) would avoid or minimize effects.

Effects of Project-Level Actions. San Joaquin kit fox occupies grassland and scrub habitats in the Restoration Area but otherwise is not expected to occur in riparian or riverine habitats that encompass most of the Action Area. These mammals create burrows for denning and refuge. Although occupied dens may be located near the river corridor, they would not be affected along any reach by the release of Interim and Restoration flows. Water from the flow releases would be restricted to the channel and adjacent lower floodplain surfaces, which are characterized by open water, riverwash, emergent wetland, and riparian scrub and forest. These habitats are not suitable for denning, although San Joaquin kit fox may forage and disperse through the river corridor or the Eastside Bypass. Implementing the Proposed Action would not affect the ability of this species to carry out these activities; the San Joaquin kit fox is mobile and wide-ranging and often uses road crossings and culverts to traverse aquatic features. It preys on a wide variety of terrestrial animals, and foraging habitat would remain plentiful along the river corridor, Eastside Bypass, and adjacent habitats. Therefore, implementing the Proposed Action would not result in any adverse direct effects on the species.

Effects of Program-Level Actions. San Joaquin kit fox has been observed in the Restoration Area. Dens could be lost or disturbed during construction of setback levees, bypass structures, haul and access roads, and staging areas; modifications of channels in the bypass system; or other ground-disturbing activities. Thus, implementing the program-level actions could adversely affect this species. However, conservation measures have been incorporated into the Conservation Strategy to avoid, minimize, and compensate for adverse effects on San Joaquin kit fox (Table 3-4). These measures include conducting preconstruction surveys to identify potential dens and establish avoidance zones and restricted construction periods around active dens (SJKF-1). Further, additional compensation may be required, in consultation with USFWS and DFG, if an unoccupied den needs to be removed (SJKF-2). Therefore, with the implementation of these conservation measures, effects on San Joaquin kit fox would be avoided or minimized.

Critical Habitat for San Joaquin Kit Fox. Critical habitat has not been designated for San Joaquin kit fox; therefore, none would be adversely modified as a result of implementing the Proposed Action.

Recovery Plan for San Joaquin Kit Fox. Recovery goals for San Joaquin kit fox are identified in the *Recovery Plan for Upland Species of the San Joaquin Valley, California*

(USFWS 1998a). The San Joaquin kit fox recovery area overlaps with portions of the Restoration Area; thus, the Action Area includes areas identified as important to the recovery of the species. Implementing the Proposed Action would be unlikely to have a substantial effect on recovery goals for San Joaquin kit fox because Interim and Restoration flows would be restricted to channels that are seasonally inundated under existing conditions and are unlikely to provide important habitat for the species.

6.2 Interrelated and Interdependent Actions

Interrelated actions are those that are part of a larger action and that depend on the larger action for their justification (50 CFR 402.02). Interdependent actions are those that have no significant independent utility apart from the action that is under consultation. Interrelated and interdependent actions are activities that would not occur “but for” the Proposed Action.

The joint USFWS/NMFS *Endangered Species Consultation Handbook* (USFWS and NMFS 1998) explains (on page 4-27) that although an existing dam is related to a later action, it is considered part of baseline because it has independent utility. Ongoing effects of a dam therefore are not considered effects of the proposed action. Thus, if a dam can exist independent of a proposed action, the operation of the dam is not interrelated or interdependent, and effects of the dam are not considered part of the effects of the proposed action under consultation.

The Proposed Action would increase Delta exports during most months and water year types, but only within the parameters defined by the applicable laws, regulations, BOs, and court orders in place at the time of operation. The increased diversions could result in higher entrainment risks for fish located in the south Delta; however, increased San Joaquin River inflows, and ratios of the inflows to reverse flows predicted for the Proposed Action, are expected to reduce the number of fish at risk of entrainment. The increased risk of fish entrainment in the south Delta is expected to be offset by the reduction in numbers of fish at risk.

The Jones and Banks export facilities are the largest in the south Delta, and entrain millions of fish each year (Reclamation 2008). The facilities have fish screens used to salvage fish greater than a certain size (around 20 mm), but many of the salvaged fish are assumed not to survive their return to the Delta (Kimmerer 2004). The loss of fish at the facilities has been shown to contribute to recent declines of Central Valley steelhead (Reclamation 2008). Diversion effects of the Proposed Action are related not only to changes in the volume of water diverted but also to changes in flow patterns caused by the diversions that affect how fish are distributed with respect to the south Delta.

The mean level of diversions at the Jones and Banks pumping plants is expected to increase under the Proposed Action during most months and year types, with especially large increases during April of all except Wet water year types (Figure 6-5). The greatest increases (about 23 percent) are predicted for Dry water year types in April (Figure 6-5). Under baseline conditions, April is expected to have the highest percent of years (more than 40 percent) with an increase in monthly Jones and Banks pumping plant diversion rates of greater than 10 percent. The largest average reduction in the diversions (about 6 percent) is expected for February of Below Normal water years.

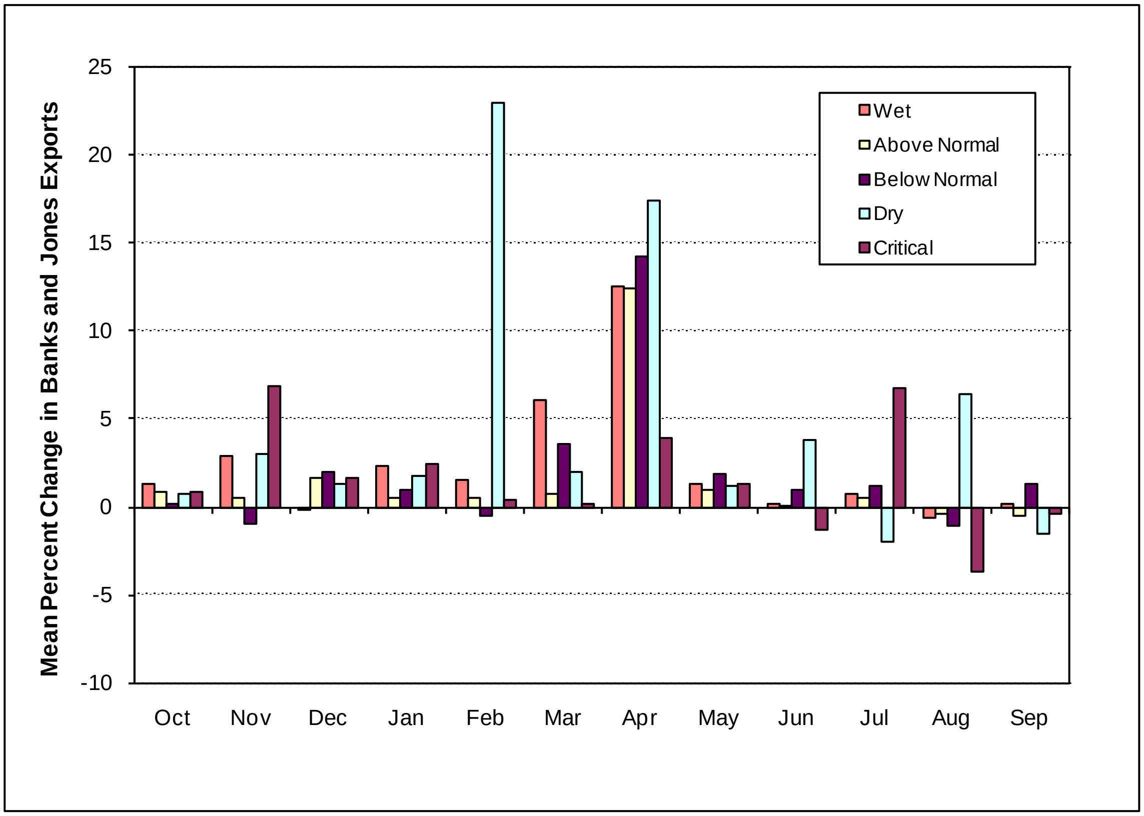

Figure 6-5.
Mean Percent Changes in Diversions at Banks and Jones Facilities

The Proposed Action is predicted to result in generally higher Banks and Jones pumping plant diversions. The higher diversion rates are expected to result in greater entrainment risk for fish in the south Delta. However, the Proposed Action would increase San Joaquin River inflows, and therefore the ratio of inflows to reverse flows, in Old and Middle rivers, which would help keep fish away from the south Delta. This effect of the increased inflows and ratios is expected to offset the increased entrainment risk of south Delta fish from increased exports, resulting in no net change in steelhead entrainment.

Interim and Restoration flows reaching the Delta would be recaptured at existing facilities within the Delta consistent with applicable laws, regulations, BOs, and court orders in place at the time the water was recaptured. Compliance contributes to the not likely to adversely affect determination for steelhead caused by Jones and Banks pumping plant diversions.

No other projects have been identified that could be considered interrelated to or interdependent with the Proposed Action. Therefore, no actions that are interrelated to or interdependent with the Proposed Action could affect Federally listed species or critical habitat covered in this BA.

6.3 Cumulative Effects

Cumulative effects, as defined under Section 7 of the ESA and implementing regulations, are the effects of future State, local, or private actions that are reasonably certain to occur in the Action Area. Future Federal actions are not addressed as cumulative effects under Section 7 of the ESA. For each listed species, this section addresses the additive effect of the Proposed Action and all foreseeable, non-Federal, future actions. These effects are addressed separately for fisheries and for terrestrial plants and wildlife.

6.3.1 Methodology and Approach

For purposes of assessing cumulative effects, the Action Area consists of all areas directly or indirectly affected by the Federal action (USFWS and NMFS 1998). Listed fish species would be affected by the Proposed Action throughout the Action Area defined in Section 1.2 (“Action Area”) and Section 3.2 (“Description of the Action Area”) of this BA. Listed terrestrial plants and wildlife, however, would be affected only in the Restoration Area (i.e., those reaches of the San Joaquin River and flood bypasses between Friant Dam and the Merced River that would receive Interim and Restoration flows).

Several actions are ongoing or planned in the Restoration Area and elsewhere in the Action Area. These actions include water resource projects, resource management plans and programs, and development projects. Most of these projects, however, are likely to involve Federal funding and/or permitting; therefore, their effects would not be considered cumulative under the ESA. Future State or private actions that may not involve Federal funding and/or permitting and that could potentially affect listed species include actions that would affect or result in any of the following activities and scenarios:

- Habitat conversion or fragmentation
- Herbicide or pesticide applications
- Vegetation management, including along waterways
- Grazing practices
- Crop selection (including crop types cultivated, fallowing or idling of cropland, and abandonment of agricultural land)
- Ground-disturbing activities (including ripping of soils)
- Discharge of contaminants into waterways
- Presence of humans in natural vegetation or along waterways on agricultural lands
- Predator abundance (e.g., coyotes)
- Dispersal and establishment of invasive species

- Flow regimes of waterways
- Use of off-road vehicles and traffic levels on local roads

All these activities and scenarios can degrade habitat or cause the injury or death of listed species. For some of these activities (such as some agricultural practices), it is difficult to predict future changes and their consequences for listed species because the activities change in response to market conditions and new technologies. Nonetheless, the vulnerability of listed species to different types of actions varies, many actions are associated with particular land uses or management practices, and the distribution of potential habitat with regard to existing and planned land uses is known. This analysis uses these known relationships between types of non-Federal actions and effects on species and among habitats, non-Federal actions, and land use as the primary basis for evaluating the cumulative effects of foreseeable future actions.

Data sources for this analysis included existing and available information summarized in the environmental baseline and species accounts (see Section 4.0, “Environmental Baseline,” and Section 5.0, “Species Accounts,” respectively, of this BA), as well as land use designations of applicable general plans, land ownership information, and Williamson Act contract data.

6.3.2 Cumulative Effects on Special-Status Fish

Few non-Federal projects would result in cumulative effects to fish in the Action Area. However, fish could be affected by projects that would result in disruption of stream banks or degradation of water quality through herbicide or pesticide applications, vegetation management along waterways, grazing practices, and ground-disturbing activities.

The success of fish populations has been linked to levels of turbidity and siltation in a watershed. Prolonged exposure to high levels of suspended sediment can create a loss of visual capability, leading to a reduction in feeding and growth rates; thickening of the gill epithelium, potentially causing the loss of respiratory function; clogging and abrasion of gill filaments; and increases in stress levels, reducing the tolerance of fish to disease and toxicants (Waters 1995).

In addition, high suspended sediment levels cause the movement and redistribution of fish populations and can affect physical habitat. After the suspended sediment is deposited, it can reduce water depth in pools, decreasing the water’s physical carrying capacity for juvenile and adult fish (Waters 1995). Increased sediment loading can also degrade food-producing habitat by interfering with photosynthesis of aquatic flora and result in the displacement of aquatic fauna.

Many fish, including juvenile salmonids, are sight feeders. Turbid waters in rivers reduce the fish’s efficiency in locating and feeding on prey. Some fish, particularly juveniles, can become disoriented and leave areas where their main food sources are located, which can result in reduced growth rates.

Avoidance is the most common result of increases in turbidity and sedimentation. Fish will not occupy areas that are not suitable for survival unless they have no other option.

Therefore, habitat can become limiting in systems where high turbidity precludes a species from occupying habitat required for specific life stages.

Additional cumulative effects may result from exposures to contaminants in discharges from point and nonpoint sources. These contaminants include selenium and numerous pesticides and herbicides associated with discharges related to agricultural and urban activities. Contaminants may injure or kill salmonids by affecting food availability, growth rate, susceptibility to disease, or other physiological processes necessary for survival. Laboratory studies show that sublethal concentrations of pesticides can affect many aspects of salmon biology, including a number of behavioral effects, such as area avoidance, delayed migration, and increased stress, rendering the salmon more susceptible to predation (Ewing 1999).

6.3.3 Cumulative Effects on Special-Status Plants

Vernal Pool Plant Species

Plant species occurring in vernal pool landscapes in or near the Restoration Area include succulent owl’s-clover, Hoover’s spurge, Colusa grass, San Joaquin Valley Orcutt grass, and hairy Orcutt grass. In and near the Restoration Area, vernal pool landscapes have been eliminated or fragmented by conversion to agricultural and developed uses, and remaining vernal pools have been degraded by the activities associated with these uses (e.g., alteration of hydrology, deep ripping of soils). In addition, invasive plant species (e.g., nonnative annual grasses) have become abundant in most vernal pool landscapes and degraded vernal pool habitat value for native species.

Vernal pool landscapes remain near the Restoration Area north and south of San Joaquin River Reach 1A, in and near the Restoration Area along Reaches 4B and 5, and along the bypasses. Land near Reach 1A has a mix of natural vegetation, cropland, and developed land uses. Remaining vernal pool landscapes are primarily in private ownership and are designated in general plans for developed uses or open space; only a small portion of the land is under Williamson Act contracts. Along the bypasses, land is in natural vegetation or cropland, with the natural vegetation concentrated in a corridor along the flood bypass. General plans designate this land for agricultural uses or open space. Most remaining vernal pool landscapes are on public lands managed to sustain biodiversity (e.g., Grasslands Wildlife Management Area), and a substantial portion of the privately owned land is under Williamson Act contracts. Along Reaches 4B and 5, most remaining vernal pool complexes are on public land managed to sustain biodiversity (e.g., the San Luis NWR), and most privately owned land is under Williamson Act contracts. General plans designate all these lands for agricultural uses.

Climate change and the spread of invasive species will affect all remaining vernal pool landscapes. However, other cumulative effects would be unlikely to eliminate or degrade vernal pool habitats, or to otherwise reduce the viability of populations of vernal pool plant species, along the bypasses or Reaches 4B and 5 because most remaining vernal pool landscapes in these areas are on public land managed by USFWS, DFG, or the California Department of Parks and Recreation.

Near Reach 1A, however, non-Federal actions are likely to result in additional loss and degradation of vernal pool landscapes. Because of the mosaic of developed land uses, cropland, and natural vegetation in this area, the remaining vernal pool landscapes are already fragmented and experiencing degradation resulting from human activities, such as off-road vehicle use, agricultural activities, and actions to alter hydrology. Because population growth and additional conversion of natural vegetation to cropland or developed uses are likely to occur (particularly in areas already designated for developed land uses), additional loss, fragmentation, and degradation of vernal pool landscapes are likely to occur near Reach 1A. These effects may be substantial and may reduce the viability of vernal pool plant species in this area.

Implementing the Proposed Action would not contribute to these cumulative effects, although the program-level actions have a higher potential to affect vernal pool habitats during the construction and modification of facilities, particularly north and south of Reach 1A. Vernal pools have not been documented along the San Joaquin River or bypasses in areas seasonally inundated by river flows, and inundation of vernal pools would be avoided during implementation of the Proposed Action. Interim and Restoration flows also would not alter agricultural practices potentially affecting vernal pool plant species in the Restoration Area or involve construction activities that may adversely affect vernal pool species.

Critical Habitat for Vernal Pool Plant Species

The cumulative effects on critical habitat for vernal pool plant species would be the same as the direct and indirect effects described for vernal pool plants. Critical habitat for succulent owl’s-clover, San Joaquin Valley Orcutt grass, and hairy Orcutt grass has been designated in the Restoration Area north of San Joaquin River Reach 1A, which is the area previously described as likely to experience additional loss, fragmentation, and degradation of vernal pool landscapes as a result of non-Federal present and future actions. Critical habitat for Hoover’s spurge and Colusa grass has been designated in Reach 4B and along the Eastside and Mariposa bypasses, which is the area previously described as likely to experience little or no loss, fragmentation, or degradation. Program-level actions of the Proposed Action in Reaches 1A, 4B2, and 5 could affect adjacent critical habitat and could modify primary constituent elements of these critical habitats, thus contributing to cumulative effects.

Palmate-Bracted Birds-Beak

Palmate-bracted birds-beak grows in alkaline soils in scrub and grassland vegetation. In the Restoration Area, suitable habitat for this species has been substantially reduced, fragmented, and degraded by conversion of natural vegetation to agricultural and developed land uses and by the activities associated with those land uses that affect remaining natural vegetation (e.g., uses of off-road vehicles and alterations to hydrology). Currently, major threats to palmate-bracted birds-beak are loss or degradation of habitat from incompatible grazing practices, hydrologic alterations, use of off-road vehicles, and conversion to agricultural and developed uses. In addition, potential effects from climate change are not well understood but could be considerable.

Palmate-bracted birds-beak has been documented near the Restoration Area south of San Joaquin River Reach 2A and between the river and the Chowchilla Bypass; therefore, occupied or potentially suitable habitat may exist in the Restoration Area in Reach 2A or 3, the Chowchilla Bypass, or the upstream segment of the Eastside Bypass. In addition, alkali sink habitat exists south of the Restoration Area in the North Grasslands Wildlife Area. Land along Reaches 2A and 3 and the bypasses is primarily privately owned, in agricultural use, designated in general plans for agricultural use, and primarily under Williamson Act contracts. The main exception is land designated for developed land uses in Firebaugh in Reach 3; almost all of this land, however, is already in developed or agricultural use.

Therefore, additional conversion of habitat to urban land uses and an increase in activities associated with urbanization and increased population may not affect palmate-bracted birds-beak in the Restoration Area. Instead, the primary future actions that would affect palmate-bracted birds-beak are related to agricultural activities. Agricultural activities that would potentially affect this species, its pollinators, or its habitat include changes in grazing practices, use of off-road vehicles, herbicide use, and conversion of natural vegetation to row or field crops. Most (and possibly all) potential habitat in these portions of the Restoration Area is not managed to sustain biodiversity, and several agricultural activities could eliminate or degrade habitat; therefore, some additional loss or degradation of palmate-bracted birds-beak habitat is likely.

Occupied palmate-bracted birds-beak habitat or habitat potentially suitable for the species has not been documented along the San Joaquin River or bypasses in areas seasonally inundated by river flows; therefore, occupied and potentially suitable habitat would not be inundated during implementation of Interim and Restoration flows. Interim and Restoration flows also would not alter agricultural practices potentially affecting palmate-bracted birds-beak in the Restoration Area. While program-level actions may involve vegetation removal and ground-disturbing activities in areas where this species may be present, implementing the Proposed Action would not contribute to cumulative effects on this species.

6.3.4 Cumulative Effects on Special-Status Wildlife

Vernal Pool Invertebrates

Vernal pool invertebrates present in vernal pool landscapes in and near the Restoration Area include Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp. Cumulative effects on vernal pool landscapes in and near the Restoration Area were described previously (see “Vernal Pool Plant Species”). Vernal pool invertebrates also would experience those cumulative effects. Vernal pool landscapes north of Reach 1A would likely experience additional loss, fragmentation, and degradation. Vernal pool landscapes in Reach 4B and along the Eastside and Mariposa bypasses are likely to experience little or no loss, fragmentation, or degradation as cumulative effects of present and future non-Federal actions. Project-level actions of the Proposed Action would not affect vernal pool landscapes and, thus, would not contribute to these cumulative effects. Program-level actions of the Proposed Action could contribute to these cumulative effects through the fill of vernal pools, alteration of hydrology and ecosystem function, and fragmentation of remaining habitats.

Critical Habitat for Vernal Pool Invertebrates

The effects on critical habitat for vernal pool invertebrates would be the same as described for vernal pool plants. Critical habitat for vernal pool fairy shrimp has been designated in the Restoration Area north of Reach 1A. These vernal pool landscapes are likely to experience additional loss, fragmentation, and degradation. Critical habitat for Conservancy fairy shrimp, longhorn fairy shrimp, vernal pool fairy shrimp, and vernal pool tadpole shrimp has been designated in Reaches 4B and 5 and along the Eastside and Mariposa bypasses. These vernal pool landscapes are likely to experience little or no loss, fragmentation, or degradation as cumulative effects of non-Federal present and future actions. Project-level actions of the Proposed Action would not affect the primary constituent elements of these critical habitats and, thus, would not contribute to these cumulative effects. Potential program-level actions in Reaches 1A, and to a lesser extent in Reaches 4B and 5, could affect adjacent critical habitat and could modify primary constituent elements of these critical habitats, thus contributing to cumulative effects.

Valley Elderberry Longhorn Beetle

Valley elderberry longhorn beetle is found only in association with its host plant, the elderberry shrub, which grows in riparian vegetation. This species is threatened by habitat loss and through predation and displacement by the invasive Argentine ant.

The extent of valley elderberry longhorn beetle habitat has been substantially reduced throughout its range, including the Restoration Area. The San Joaquin River has changed dramatically since the early part of the nineteenth century. The river is now largely confined within constructed levees and bounded by agricultural and urban development, flows are regulated through dams and water diversions, and floodplain habitats have been fragmented and reduced in size and diversity (McBain and Trush 2002). As a result, riparian communities and associated wildlife have changed substantially from historical conditions (Jones and Stokes 1998a). The presence of Friant Dam reduces the frequency of scouring flows, which has resulted in a gradual decline of bare gravel and sandbar surfaces. Over time, the vegetation succession of riparian scrub to forest is no longer balanced by periodic loss of forest to the river caused by erosion and appearance of new riparian scrub on sand and gravel bars. In addition, operation of Friant Dam has caused the loss of gradually declining flows in spring, which are periodically necessary to disperse willow and cottonwood seeds and establish seedlings of these riparian tree and shrub species. Drought conditions caused by diversions have caused riparian vegetation to be lost in several reaches of the river (e.g., Reaches 2, 4A), and urban and agricultural development have caused a gradual loss of area available for riparian habitat (Jones and Stokes 1998a).

In the Restoration Area, the remaining riparian vegetation is primarily in narrow corridors, which consist mainly of shrub-dominated scrubs, but riparian vegetation also grows in narrow bands and some wider patches of riparian forest along all reaches of the San Joaquin River. In the bypass system, riparian vegetation consists of discontinuous narrow corridors and patches. In the remaining riparian vegetation of the Restoration

Area, elderberry shrubs are widespread in Reaches 1 and 2 and sparsely distributed in Reaches 3, 4, and 5; their presence in the bypass system has not been documented.

Primary factors affecting the extent of native riparian vegetation (including elderberry shrubs) in the Restoration Area are (1) availability of sufficient surface water and groundwater to support plant establishment, growth, and survival, (2) spread of invasive, nonnative plants that displace native riparian vegetation, (3) disturbances that remove established riparian vegetation (e.g., levee maintenance activities, fires), and (4) adjacent land uses that constrain the maximum extent of riparian vegetation and are often the sources of invasive species and disturbances.

Non-Federal actions would affect some of these limiting factors, and their cumulative effects would differ among river reaches and bypasses. The availability of surface water and groundwater along the San Joaquin River is not anticipated to change substantially as a result of non-Federal actions. Invasive plants, however, are anticipated to continue to spread downstream. In Reach 1A, red sesbania and several other invasive species are already widespread and have displaced large areas of native vegetation. These species would likely become more abundant downstream, displacing native vegetation in the remaining riparian areas (and resulting in a net replacement of native herbaceous and tree-dominated riparian vegetation with nonnative, shrub-dominated vegetation). In addition, valley elderberry longhorn beetle could be affected by additional spread of Argentine ants in riparian vegetation in the Restoration Area; however, the current distribution and ongoing spread of Argentine ants in the Restoration Area are unknown.

In the absence of changes to adjacent land uses or management of the river corridor, the frequency and effects of disturbances that would remove riparian vegetation would remain similar to existing conditions. However, non-Federal actions are likely to change land uses and management of the river corridor along Reach 1A. Much of the land in and adjacent to the Restoration Area in Reach 1A is privately owned and designated for developed land uses but is currently cropland or natural vegetation; these changes would likely increase the disturbance of riparian vegetation along Reach 1A. Along Reaches 1B through 5, changes in land use would be more limited because most private land adjacent to the river corridor is cropland, designated in general plans for agricultural use, and under Williamson Act contracts. In addition, along Reaches 4B and 5, a substantial portion of adjacent land is Federally owned or State-owned and managed to sustain biodiversity. However, some land use changes could still occur along Reaches 1B–5, particularly the conversion of remaining natural vegetation on private land to cropland.

The cumulative effect of non-Federal actions would likely be a reduction in the extent and quality of valley elderberry longhorn beetle habitat, and this could reduce the valley elderberry longhorn beetle population in the Restoration Area. Implementing the Proposed Action would not increase these cumulative effects. Interim and Restoration flows may increase plant establishment or mortality at some locations, but these flows would be unlikely to substantially alter the extent of existing riparian vegetation. Most elderberry shrubs are not anticipated to be inundated by Interim and Restoration flows, and these flows are not likely to result in loss of elderberry shrubs or any resident beetles. Further, the invasive plant management included in the Physical Monitoring and

Management Plan (Appendix D of the Draft PEIS/R; Reclamation and DWR, 2011) would limit the spread of invasive species for several years and thus reduce their degradation of valley elderberry longhorn beetle habitat.

Program-level actions of the Proposed Action have the potential to result in disturbance and loss of habitat during construction and modification of facilities, particularly where these activities are conducted near riparian habitat. Therefore, these actions could increase these cumulative effects.

California Tiger Salamander

California tiger salamander is associated with vernal pool landscapes and has been documented in vernal pool landscapes in the San Luis NWR and at Great Valley Grasslands State Park. It is threatened by the introduction of exotic predators (e.g., bullfrogs, mosquitofish), habitat fragmentation, vehicle-related mortality, and rodent-control programs that result in loss of aestivation habitat.

Cumulative effects on California tiger salamander would be similar to those described previously for vernal pool plants. However, California tiger salamander would experience greater adverse effects from habitat fragmentation and human activities in adjacent areas because of its dispersal and seasonal movements. Like vernal pool plant species, and for the same reasons given previously, California tiger salamander would likely experience habitat loss and degradation and reduced population viability in vernal pool landscapes north and south of Reach 1A. However, except for the effects of climate change and the continued spread of invasive plants, cumulative effects would be unlikely to eliminate or degrade vernal pool habitats or otherwise affect California tiger salamander along the bypasses or Reaches 4B and 5. Implementing the Proposed Action would not affect vernal pool landscapes and, thus, the Proposed Action would not contribute to these cumulative effects.

Program-level actions of the Proposed Action could result in the direct fill of vernal pools, alteration of hydrology and ecosystem function, and fragmentation of remaining habitats, including disturbing breeding, foraging, refuge, and dispersal habitats for this species. The potential for program-level actions to cause direct loss of habitat or indirectly result in elimination of areas essential to this species' seasonal movement would contribute to these cumulative effects.

Critical Habitat for California Tiger Salamander

Critical habitat for California tiger salamander abuts the Restoration Area on either side in Reach 1A and exists in the Restoration Area at one location along Reach 1A. Cumulative effects on California tiger salamander critical habitat would be the same as cumulative effects described for California tiger salamander in vernal pool landscapes along Reach 1A. Implementing project-level actions of the Proposed Action would not contribute to these cumulative effects because it would not affect vernal pool landscapes and thus would not affect the primary constituent elements of critical habitat for California tiger salamander. However, program-level actions in Reach 1A could affect adjacent critical habitat and could also modify primary constituent elements of these critical habitats, thus contributing to cumulative effects.

Blunt-Nosed Leopard Lizard

Blunt-nosed leopard lizards are found in upland areas with sandy soils and scattered vegetation, throughout the San Joaquin Valley and adjacent foothills. Much – perhaps most – blunt-nosed leopard lizard habitat has been lost or fragmented by conversion to cropland or developed land uses, and much of the remaining habitat has been degraded by human disturbance and the spread of nonnative plants. Habitat loss, fragmentation, and degradation remain the primary threats to blunt-nosed leopard lizard.

Most upland vegetation in and near the Restoration Area has been converted to cropland or developed land uses. Remaining natural upland vegetation is fragmented and to some extent degraded from past and ongoing human activities.

However, in uplands that remain in natural vegetation, some potential and/or occupied habitat may exist, including along the Eastside Bypass. Blunt-nosed leopard lizards would be most likely to use areas adjacent to alkali scrub habitat with sandy soils, rodent burrows, and sparse vegetation.

For upland habitats in general, cumulative effects on remaining habitat for blunt-nosed leopard lizards would result in additional habitat loss, fragmentation, and degradation. Interim and Restoration flows would not add to these cumulative effects. At present, all reaches that would receive Interim and Restoration flows are seasonally inundated, with the exception of Reaches 2A and 2B and portions of the Eastside Bypass, which are periodically inundated by flood flows. The portions of Reaches 2A and 2B that could be inundated by Interim and Restoration flows are characterized by sandy riverwash and gravelly substrate. Habitat conditions in these areas are not highly suitable; therefore, the presence of blunt-nosed leopard lizard is unlikely. Potential habitat could be disturbed or lost as a result of program-level actions, which may include the construction of setback levees, bypass structures, access roads, and staging areas. However, the Conservation Strategy (Table 3-4) includes a measure to avoid affecting habitat occupied by blunt-nosed leopard lizard.

Giant Garter Snake

Giant garter snake is an aquatic snake found in aquatic and emergent wetland habitats (e.g., along ditches and canals, in rice fields) and adjacent uplands. In the San Joaquin Valley, the distribution and abundance of this species has been substantially reduced. In and near the Restoration Area, giant garter snake occurs in suitable habitat in the San Luis NWR Complex, in the Mendota Wildlife Area, and at the Mendota Pool, and is expected to occur in suitable habitat elsewhere in the Restoration Area. The species is threatened by habitat loss and fragmentation from expansion of urban areas and by habitat degradation from incompatible agricultural practices (e.g., intensive vegetation control along canals and ditches).

Effects of present and future non-Federal actions on giant garter snakes and their aquatic and wetland habitats are similar to the effects described previously for riparian habitats (see “Valley Elderberry Longhorn Beetle”): some loss or disturbance of habitat from localized changes in land use or agricultural practices, as well as spread of invasive plants converting herbaceous vegetation-dominated riparian scrub and wetland vegetation to vegetation dominated by nonnative shrubs. However, the extent of these cumulative effects on giant garter snakes and their habitat would be less than described for riparian vegetation because a greater portion of giant garter snake habitat is on Federal and State land managed to sustain biodiversity.

The cumulative effect of non-Federal actions would likely be some reduction in the extent and quality of giant garter snake habitat, which could reduce the snake population in the Restoration Area. Implementing the Proposed Action would not increase these cumulative effects. Interim and Restoration flows would be unlikely to substantially alter the extent or quality of existing habitat, although the increase in flow may enhance giant garter snake habitat. In addition, invasive plant management included in the Proposed Action's Physical Monitoring and Management Plan (Appendix D of the Draft PEIS/R; Reclamation and DWR, 2011) would limit the spread of these invasive species for several years and thus reduce their degradation of giant garter snake habitat. However, as described for giant garter snake above, program-level actions could result in disturbance, modification, and/or loss of both aquatic and upland habitat components for this species. Thus, program-level actions of the Proposed Action would increase these cumulative effects.

Western Yellow-Billed Cuckoo

Western yellow-billed cuckoo typically breeds in broad, well-developed and relatively closed-canopied riparian forest composed of mature willows and cottonwoods. The development of water storage and flood control systems and associated expansion of agricultural and developed land uses during the twentieth century eliminated the vast majority of the Central Valley's nesting habitat for yellow-billed cuckoo. Habitat loss remains the primary threat for this species.

As described previously (see "Valley Elderberry Longhorn Beetle"), a substantial reduction in riparian habitat has occurred, particularly as a result of the construction of Friant Dam and the existing flood control system, as well as associated conversion of historical floodplain to cropland. The remaining riparian vegetation is primarily in narrow corridors, which are primarily shrub-dominated scrubs, but also grows in narrow bands and some wider patches of riparian forest along all reaches of the San Joaquin River. Although yellow-billed cuckoo has not been documented as nesting in the Restoration Area during recent decades, it could potentially nest in these forests.

Most potential nesting habitat for yellow-billed cuckoo in the Restoration Area is of marginal quality and is located along the San Joaquin River. As described previously (see "Valley Elderberry Longhorn Beetle"), the extent of riparian vegetation and the quality of riparian habitats are expected to be reduced by the cumulative effect of non-Federal actions. In particular, invasive plants are likely to continue to spread through riparian areas along the San Joaquin River and would likely reduce the extent of riparian forest providing suitable nesting habitat for yellow-billed cuckoo. The Proposed Action's Physical Monitoring and Management Plan (Appendix D of the Draft PEIS/R; Reclamation and DWR 2011) would reduce this cumulative effect because it includes a measure that would limit the expansion of invasive plant populations for several years. The program-level actions of the Proposed Action could further increase effects on these habitats during the construction of setback levees, bypass structures, access roads, and staging areas and in-channel work that could result in the loss of trees and shrubs occupied by nesting birds.

Least Bell's Vireo

Primary threats to least Bell's vireo are habitat loss and nest parasitism by brown-headed cowbird. Threats also include trampling of vegetation and nests by livestock and humans, as well as habitat degradation resulting from the spread of invasive plants, particularly giant reed.

Least Bell's vireo historically nested in riparian vegetation throughout the Restoration Area but was extirpated from the Central Valley by 1980. The species is now expanding its range, and in 2005 and 2006, least Bell's vireos successfully nested at the San Joaquin River NWR.

As described previously (see "Valley Elderberry Longhorn Beetle"), the extent and habitat quality of riparian vegetation are expected to be reduced by the cumulative effect of non-Federal actions. In particular, invasive plants are likely to continue to spread through riparian areas along the San Joaquin River and would likely reduce the extent of suitable nesting habitat for least Bell's vireo. In addition, potential nesting habitat could experience greater disturbance from human activities along Reach 1A. Implementing the Proposed Action would not add to these cumulative effects. Least Bell's vireos would migrate into the Restoration Area sometime in April and would naturally construct their nests above the level of Interim and Restoration flows. Furthermore, the number of nests established below the levels of Interim and Restoration flows during the breeding season is expected to be low, given the rarity of nesting least Bell's vireos in the Restoration Area and the prevalence of surrounding habitats suitable for nesting. Program-level actions of the Proposed Action could add to these cumulative effects during construction activities that would disturb vegetation and potential nesting habitat.

Fresno Kangaroo Rat

Fresno kangaroo rat lives in alkali scrub habitat but may be extirpated from the Restoration Area. Primary threats to Fresno kangaroo rat are habitat loss from expansion of cropland and developed land uses, as well as incompatible grazing practices.

As described previously (see "Palmate-Bracted Birds-Beak"), alkali scrub habitats in the Restoration Area have been substantially reduced, fragmented, and degraded by conversion of natural vegetation to agricultural and developed land uses and by the activities associated with those land uses that affect remaining natural vegetation (e.g., use of off-road vehicles, alterations to hydrology). The primary future actions affecting alkali scrub are related to agricultural activities, including changes in grazing practices, use of off-road vehicles, and conversion of natural vegetation to row or field crops. Because most – and possibly all – potential habitat in these portions of the Restoration Area is not managed to sustain biodiversity, and various agricultural activities could eliminate or degrade habitat, additional loss or degradation of Fresno kangaroo rat habitat is likely.

Occupied Fresno kangaroo rat habitat or habitat potentially suitable for the species has not been documented along the San Joaquin River or bypasses in areas seasonally inundated by river flows; therefore, inundation of occupied and potentially suitable habitat would be avoided during implementation of Interim and Restoration flows. Interim and Restoration flows also would not alter agricultural practices potentially affecting Fresno kangaroo rat in the Restoration Area. Although construction activities related to program-level actions are unlikely to affect known populations of this species, these activities could affect potential habitat on private land adjacent to Reach 2B that has not been surveyed. Therefore, implementing the Proposed Action would not contribute measurably to cumulative effects.

Riparian (San Joaquin Valley) Woodrat

The riparian woodrat lives in riparian areas, primarily riparian forest with a dense shrub understory. Historically, this species likely occurred throughout the northern San Joaquin Valley, but it currently has a limited distribution at the confluence of the San Joaquin and Stanislaus rivers. It is not expected to occur upstream from the Merced River. Primary threats to riparian woodrat are habitat loss by conversion to cropland or clearing of vegetation, as well as habitat disturbance.

Riparian habitats along the lower San Joaquin River and Stanislaus River would experience cumulative effects comparable to those in the Restoration Area (see “Valley Elderberry Longhorn Beetle”), and these cumulative effects would be likely to adversely affect riparian woodrat. Implementing the Proposed Action would not add to these cumulative effects. Because Interim and Restoration flows would have only a minimal effect on riparian habitats downstream from the Merced River, no effect on riparian woodrat would occur. Program-level actions of the Proposed Action would not occur downstream from the Merced River confluence; therefore, these activities would not contribute to cumulative effects on this species.

Riparian Brush Rabbit

Riparian brush rabbit inhabits riparian vegetation but has been extirpated from the Delta and most of the lower San Joaquin River and its tributaries. Currently, this species has a limited distribution along the lower portions of the San Joaquin and Stanislaus rivers and is not expected to occur upstream from the confluence with the Merced River.

Riparian habitats along the San Joaquin River from the Merced River to the Delta and along the lower Stanislaus River would experience cumulative effects comparable to those in the Restoration Area (see “Valley Elderberry Longhorn Beetle”). These cumulative effects on riparian areas would likely adversely affect riparian brush rabbit. Interim and Restoration flows would not add to these cumulative effects. Interim and Restoration flows would have only a minimal effect on riparian habitats downstream from the Merced River; thus, no effect on riparian brush rabbit would occur. Program-level actions of the Proposed Action would not occur downstream from the Merced River confluence, and these actions would not contribute to cumulative effects on this species.

San Joaquin Kit Fox

San Joaquin kit fox is a wide-ranging carnivore that uses primarily grassland, seasonal wetland, and open scrubs and woodlands. The distribution and abundance of this species have been substantially reduced by the loss and fragmentation of habitat by conversion of natural vegetation to cropland and developed land uses, human disturbance, rodenticide use, and competitive displacement and predation by the domestic dog, red fox, and coyote.

Most natural upland vegetation in and near the Restoration Area has been converted to cropland or developed land uses. The remaining natural upland vegetation is fragmented and degraded to some extent by disturbances originating from adjacent agricultural and developed land uses. Developed and agricultural land uses have also increased the density of domestic dogs and coyotes that displace San Joaquin kit fox. However, this species still occupies some of the remaining grassland and scrub habitats in the Restoration Area.

Present and future non-Federal actions could result in additional degradation and loss of upland habitats. In addition, an increased human population in the region would likely increase the abundance of domestic dogs and scavenging coyotes that could displace San Joaquin kit fox. Potential effects of climate change and further spread of invasive species on San Joaquin kit fox are unknown.

While program-level actions could add to these cumulative effects, as associated construction activities could result in loss of or disturbance to dens, project-level actions, including Interim and Restoration flows, would not inundate occupied dens, nor would they interfere with foraging or dispersal through the river corridor or the Eastside Bypass. Therefore, the Proposed Action would not add measurably to these cumulative effects.

Chapter 7.0
Conclusions

Based on the review of the environmental baseline and direct, indirect, and cumulative effects, the project- and program-level actions would not likely adversely affect any Federally listed fish species or designated critical habitat (Table 7-1). Implementing the Proposed Action would not likely adversely affect Central Valley steelhead DPS, southern DPS of the North American green sturgeon, delta smelt, or Sacramento River winter-run or Central Valley spring-run Chinook salmon ESUs. Listed fish species, particularly steelhead and delta smelt, may have slightly increased risk of entrainment at the Jones and Banks pumping plants caused by increased exports, but these adverse effects would be offset by the increased San Joaquin River inflow to the Delta. This increased San Joaquin River inflow also would decrease the number of steelhead that move through the south Delta. Additionally, Delta export operations would be consistent with applicable laws, regulations, BOs, and court orders in place during the Proposed Action and would provide additional protection to special-status fish species either directly or indirectly. Therefore, the Proposed Action, including the Interim and Restoration flows, would not increase take above acceptable limits established by either NMFS (2009a) or USFWS (2008). There is a potential for adverse effects due to water quality issues, but the level of effect at the time fish will inhabit the Restoration Area is unknown and speculative.

Based on the review of the environmental baseline and direct, indirect, and cumulative effects, the project-level actions would not likely adversely affect any Federally listed plant or animal species or designated critical habitat, although the program-level actions may affect listed species (Table 7-2). The conservation strategy includes avoidance, minimization, and compensation measures for all listed terrestrial species that would reduce the overall effects of the Proposed Action.

Table 7-1.
Federally Protected Aquatic Species That May Be Affected by Implementing the Proposed Action

Species	Critical Habitat	Project-Level Actions – Conclusion	Program-Level Actions – Conclusion
Central Valley steelhead *Oncorhynchus mykiss*	Designated critical habitat in action area (70 Federal Register 52488, September 2, 2005)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species or adversely modify critical habitat
Sacramento River winter-run Chinook salmon *Oncorhynchus tshawytscha*	Designated critical habitat not in action area (58 Federal Register 33212, June 16, 1993)	Not likely to adversely affect species or adversely modify critical habitat or essential fish habitat	Not likely to adversely affect species or adversely modify critical habitat or essential fish habitat
Central Valley spring-run Chinook salmon *Oncorhynchus tshawytscha*	Designated critical habitat not in action area (70 Federal Register 52488, September 2, 2005)	Not likely to adversely affect species or adversely modify critical habitat or essential fish habitat	Not likely to adversely affect species or adversely modify critical habitat or essential fish habitat
Central Valley fall-/late fall-run Chinook salmon *Oncorhynchus tshawytscha*	No designated critical habitat	No adverse effect to essential fish habitat	No adverse effect to essential fish habitat
Southern distinct population segment of the North American green sturgeon *Acipenser medirostris*	No designated critical habitat	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species
Delta smelt *Hypomesus transpacificus*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species or adversely modify critical habitat
Starry flounder *Plathichthys stellatus*	No designated critical habitat	No adverse effect to essential fish habitat	No adverse effect to essential fish habitat

Table 7-2.
Federally Listed Terrestrial Species That May Be Affected by Implementing the Proposed Action

Species	Critical Habitat	Project-Level Actions – Conclusion	Program-Level Actions – Conclusion
Succulent owl's-clover *Castilleja campestris ssp. succulenta*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
Hoover's spurge *Chamaesyce hooveri*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
Palmate-bracted bird's-beak *Cordylanthus palmatus*	None designated	Not likely to adversely affect species	Could affect, but not likely to adversely affect species
Colusa grass *Neostapfia colusana*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
San Joaquin Valley Orcutt grass *Orcuttia inaequalis*	Designated critical habitat adjacent to action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
Hairy Orcutt grass *Orcuttia pilosa*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
Conservancy fairy shrimp *Branchinecta conservatio*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Could affect, but not likely to adversely affect species; could adversely modify critical habitat
Longhorn fairy shrimp *Branchinecta longiantenna*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Could affect, but not likely to adversely affect species; could adversely modify critical habitat
Vernal pool fairy shrimp *Branchinecta lynchi*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Could affect, but not likely to adversely affect species; could adversely modify critical habitat
Vernal pool tadpole shrimp *Lepidurus packardi*	Designated critical habitat in action area (70 Federal Register 46924–46999)	Not likely to adversely affect species or adversely modify critical habitat	Could affect, but not likely to adversely affect species; could adversely modify critical habitat

Table 7-2.
Federally Listed Terrestrial Species That May Be Affected by Implementing the Proposed Action (contd.)

Species	Critical Habitat	Project-Level Actions – Conclusion	Program-Level Actions – Conclusion
Valley elderberry longhorn beetle *Desmocerus californicus dimorphus*	No designated critical habitat in action area (45 Federal Register 52803–52807)	Not likely to adversely affect species; could beneficially affect species	Could affect, but not likely to adversely affect species
California tiger salamander *Ambystoma californiense*	Designated critical habitat in action area (70 Federal Register 49379–49458)	Not likely to adversely affect species or adversely modify critical habitat	Could affect, but not likely to adversely affect species; could adversely modify critical habitat
Blunt-nosed leopard lizard *Gambelia sila*	None designated	Not likely to adversely affect species	Could affect, but not likely to adversely affect species
Giant garter snake *Thamnophis gigas*	None designated	Not likely to adversely affect species; could beneficially affect species	Could affect, but not likely to adversely affect species
Western yellow-billed cuckoo *Coccyzus americanus occidentalis*	None designated	Not likely to adversely affect species	Could affect, but not likely to adversely affect species
Least Bell's vireo *Vireo bellii pusillus*	No designated critical habitat in action area (59 Federal Register 4845–4867)	Not likely to adversely affect species	Could affect, but not likely to adversely affect species
Fresno kangaroo rat *Dipodomys nitratoides exilis*	No designated critical habitat in action area (50 Federal Register 4222–4226)	Not likely to adversely affect species or adversely modify critical habitat	Not likely to adversely affect species; could adversely modify critical habitat
Riparian (San Joaquin Valley) woodrat *Neotoma fuscipes riparia*	None designated	Not likely to adversely affect species	Could affect; could beneficially affect species
Riparian brush rabbit *Sylvilagus bachmani riparius*	None designated	Not likely to adversely affect species	Not likely to adversely affect species
San Joaquin kit fox *Vulpes macrotis mutica*	None designated	Not likely to adversely affect species	Could affect, but not likely to adversely affect species

Source: USFWS 2011, compiled by AECOM in 2011

Chapter 8.0
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Chapter 9.0
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Appendix A

USFWS Species List Response Letter

Programmatic Biological Assessment

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2011

United States Department of the Interior
FISH AND WILDLIFE SERVICE
Sacramento Fish and Wildlife Office
2800 Cottage Way, Room W-2605
Sacramento, California 95825

February 8, 2011

Document Number: 110208034218

Tammie Beyerl
AECOM
2020 L Street
Sacramento, CA 95811

Subject: Species List for San Joaquin River Restoration

Dear: Interested party

We are sending this official species list in response to your February 8, 2011 request for information about endangered and threatened species. The list covers the California counties and/or U.S. Geological Survey 7½ minute quad or quads you requested.

Our database was developed primarily to assist Federal agencies that are consulting with us. Therefore, our lists include all of the sensitive species that have been found in a certain area *and also ones that may be affected by projects in the area*. For example, a fish may be on the list for a quad if it lives somewhere downstream from that quad. Birds are included even if they only migrate through an area. In other words, we include all of the species we want people to consider when they do something that affects the environment.

Please read Important Information About Your Species List (below). It explains how we made the list and describes your responsibilities under the Endangered Species Act.

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be May 09, 2011.

Please contact us if your project may affect endangered or threatened species or if you have any questions about the attached list or your responsibilities under the Endangered Species Act. A list of Endangered Species Program contacts can be found at www.fws.gov/sacramento/es/branches.htm.

Endangered Species Division

TAKE PRIDE IN AMERICA

U.S. Fish & Wildlife Service

Sacramento Fish & Wildlife Office

Federal Endangered and Threatened Species that Occur in or may be Affected by Projects in the Counties and/or U.S.G.S. 7 1/2 Minute Quads you requested

Document Number: 110208034218

Database Last Updated: April 29, 2010

Quad Lists

Listed Species

Invertebrates

Branchinecta conservatio
- Conservancy fairy shrimp (E)
- Critical habitat, Conservancy fairy shrimp (X)

Branchinecta longiantenna
- Critical habitat, longhorn fairy shrimp (X)
- longhorn fairy shrimp (E)

Branchinecta lynchi
- Critical habitat, vernal pool fairy shrimp (X)
- vernal pool fairy shrimp (T)

Desmocerus californicus dimorphus
- valley elderberry longhorn beetle (T)

Lepidurus packardi
- Critical habitat, vernal pool tadpole shrimp (X)
- vernal pool tadpole shrimp (E)

Fish

Acipenser medirostris
- green sturgeon (T) (NMFS)

Hypomesus transpacificus
- delta smelt (T)

Oncorhynchus mykiss
- Central Valley steelhead (T) (NMFS)
- Critical habitat, Central Valley steelhead (X) (NMFS)

Oncorhynchus tshawytscha
- Central Valley spring-run chinook salmon (T) (NMFS)
- winter-run chinook salmon, Sacramento River (E) (NMFS)

Amphibians

Ambystoma californiense
- California tiger salamander, central population (T)
- Critical habitat, CA tiger salamander, central population (X)

Rana draytonii
- California red-legged frog (T)

Reptiles

Gambelia (=Crotaphytus) sila
blunt-nosed leopard lizard (E)

Thamnophis gigas
giant garter snake (T)

Mammals

Dipodomys ingens
giant kangaroo rat (E)

Dipodomys nitratoides exilis
Critical habitat, Fresno kangaroo rat (X)
Fresno kangaroo rat (E)

Vulpes macrotis mutica
San Joaquin kit fox (E)

Plants

Castilleja campestris ssp. succulenta
Critical habitat, succulent (=fleshy) owl's-clover (X)
succulent (=fleshy) owl's-clover (T)

Caulanthus californicus
California jewelflower (E)

Chamaesyce hooveri
Critical habitat, Hoover's spurge (X)
Hoover's spurge (T)

Cordylanthus palmatus
palmate-bracted bird's-beak (E)

Monolopia congdonii (=Lembertia congdonii)
San Joaquin woolly-threads (E)

Neostapfia colusana
Colusa grass (T)
Critical habitat, Colusa grass (X)

Orcuttia inaequalis
Critical habitat, San Joaquin Valley Orcutt grass (X)
San Joaquin Valley Orcutt grass (T)

Orcuttia pilosa
Critical habitat, hairy Orcutt grass (X)
hairy Orcutt grass (E)

Pseudobahia bahiifolia
Hartweg's golden sunburst (E)

Candidate Species

Birds

Coccyzus americanus occidentalis
Western yellow-billed cuckoo (C)

Quads Containing Listed, Proposed or Candidate Species:

JAMESAN (359B)
TRANQUILLITY (360A)
FRIANT (378B)

LANES BRIDGE (379A)
GREGG (379B)
HERNDON (379C)
FRESNO NORTH (379D)
MADERA (380A)
GRAVELLY FORD (380C)
BIOLA (380D)
FIREBAUGH NE (381A)
POSO FARM (381B)
FIREBAUGH (381C)
MENDOTA DAM (381D)
OXALIS (382A)
BROADVIEW FARMS (382D)
MILLERTON LAKE WEST (398C)
MILLERTON LAKE EAST (398D)
LITTLE TABLE MTN. (399D)
BLISS RANCH (401C)
SANDY MUSH (402A)
TURNER RANCH (402B)
DELTA RANCH (402C)
SANTA RITA BRIDGE (402D)
SAN LUIS RANCH (403A)
INGOMAR (403B)
GUSTINE (423C)
STEVINSON (423D)
NEWMAN (424D)

County Lists

No county species lists requested.

Key:

(E) *Endangered* - Listed as being in danger of extinction.

(T) *Threatened* - Listed as likely to become endangered within the foreseeable future.

(P) *Proposed* - Officially proposed in the Federal Register for listing as endangered or threatened.

(NMFS) Species under the Jurisdiction of the National Oceanic & Atmospheric Administration Fisheries Service. Consult with them directly about these species.

Critical Habitat - Area essential to the conservation of a species.

(PX) *Proposed Critical Habitat* - The species is already listed. Critical habitat is being proposed for it.

(C) *Candidate* - Candidate to become a proposed species.

(V) Vacated by a court order. Not currently in effect. Being reviewed by the Service.

(X) *Critical Habitat* designated for this species

Important Information About Your Species List

How We Make Species Lists

We store information about endangered and threatened species lists by U.S. Geological Survey 7½ minute quads. The United States is divided into these quads, which are about the size of San Francisco.

The animals on your species list are ones that occur within, **or may be affected by** projects within, the quads covered by the list.

- Fish and other aquatic species appear on your list if they are in the same watershed as your quad or if water use in your quad might affect them.
- Amphibians will be on the list for a quad or county if pesticides applied in that area may be carried to their habitat by air currents.
- Birds are shown regardless of whether they are resident or migratory. Relevant birds on the county list should be considered regardless of whether they appear on a quad list.

Plants

Any plants on your list are ones that have actually been observed in the area covered by the list. Plants may exist in an area without ever having been detected there. You can find out what's in the surrounding quads through the California Native Plant Society's online Inventory of Rare and Endangered Plants.

Surveying

Some of the species on your list may not be affected by your project. A trained biologist and/or botanist, familiar with the habitat requirements of the species on your list, should determine whether they or habitats suitable for them may be affected by your project. We recommend that your surveys include any proposed and candidate species on your list. See our Protocol and Recovery Permits pages.

For plant surveys, we recommend using the Guidelines for Conducting and Reporting Botanical Inventories. The results of your surveys should be published in any environmental documents prepared for your project.

Your Responsibilities Under the Endangered Species Act

All animals identified as listed above are fully protected under the Endangered Species Act of 1973, as amended. Section 9 of the Act and its implementing regulations prohibit the take of a federally listed wildlife species. Take is defined by the Act as "to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture, or collect" any such animal.

> Take may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or shelter (50 CFR §17.3).

Take incidental to an otherwise lawful activity may be authorized by one of two procedures:

- If a Federal agency is involved with the permitting, funding, or carrying out of a project that may result in take, then that agency must engage in a formal consultation with the Service.

  During formal consultation, the Federal agency, the applicant and the Service work together to avoid or minimize the impact on listed species and their habitat. Such consultation would result in a biological opinion by the Service addressing the anticipated effect of the project on listed and proposed species. The opinion may authorize a limited level of incidental take.

- If no Federal agency is involved with the project, and federally listed species may be taken as part of the project, then you, the applicant, should apply for an incidental take permit. The Service may issue such a permit if you submit a satisfactory conservation plan for the species that would be affected by your project.

  Should your survey determine that federally listed or proposed species occur in the area and are likely to be affected by the project, we recommend that you work with this office and the California Department of Fish and Game to develop a plan that minimizes the project's direct and indirect impacts to listed species and compensates for project-related loss of habitat. You should include the plan in any environmental documents you file.

Critical Habitat

When a species is listed as endangered or threatened, areas of habitat considered essential to its conservation may be designated as critical habitat. These areas may require special management considerations or protection. They provide needed space for growth and normal behavior; food, water, air, light, other nutritional or physiological requirements; cover or shelter; and sites for breeding, reproduction, rearing of offspring, germination or seed dispersal.

Although critical habitat may be designated on private or State lands, activities on these lands are not restricted unless there is Federal involvement in the activities or direct harm to listed wildlife.

If any species has proposed or designated critical habitat within a quad, there will be a separate line for this on the species list. Boundary descriptions of the critical habitat may be found in the Federal Register. The information is also reprinted in the Code of Federal Regulations (50 CFR 17.95). See our Map Room page.

Candidate Species

We recommend that you address impacts to candidate species. We put plants and animals on our candidate list when we have enough scientific information to eventually propose them for listing as threatened or endangered. By considering these species early in your planning process you may be able to avoid the problems that could develop if one of these candidates was listed before the end of your project.

Species of Concern

The Sacramento Fish & Wildlife Office no longer maintains a list of species of concern. However, various other agencies and organizations maintain lists of at-risk species. These lists provide essential information for land management planning and conservation efforts. More info

Wetlands

If your project will impact wetlands, riparian habitat, or other jurisdictional waters as defined by section 404 of the Clean Water Act and/or section 10 of the Rivers and Harbors Act, you will need to obtain a permit from the U.S. Army Corps of Engineers. Impacts to wetland habitats require site specific mitigation and monitoring. For questions regarding wetlands, please contact Mark Littlefield of this office at (916) 414-6580.

Updates

Our database is constantly updated as species are proposed, listed and delisted. If you address proposed and candidate species in your planning, this should not be a problem. However, we recommend that you get an updated list every 90 days. That would be May 09, 2011.

Appendix B

Sensitivity Analyses

Programmatic Biological Assessment

SAN JOAQUIN RIVER RESTORATION PROGRAM

November 2011

Table of Contents

Tables

Figures

Attachments

List of Abbreviations and Acronyms

AN	above normal
BA	Biological Assessment
BN	below normal
BO	Biological Opinion
CVP	Central Valley Project
Delta	Sacramento-San Joaquin Delta
EC	electrical conductivity
FERC	Federal Energy Regulatory Commission
LOD	level of development
NMFS	National Marine Fisheries Service
OMR	Old and Middle rivers
PEIS/R	Program Environmental Impact Statement/Environmental Impact Report
Reclamation	U.S. Department of the Interior, Bureau of Reclamation
RPA	reasonable and prudent alternative
SJRRP	San Joaquin River Restoration Program
SWP	State Water Project
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Program

1.0 Introduction

The purpose of the sensitivity analyses presented below is to evaluate how the implementation of the reasonable and prudent alternatives (RPAs) of the U.S. Fish and Wildlife Service (USFWS) 2008 Biological Opinion (BO) on the Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP) (2008 USFWS CVP/SWP Operations BO) and the National Marine Fisheries Service (NMFS) 2009 Final Biological and Conference Opinion on the Long-Term Operations of the CVP and SWP (2009 NMFS CVP/SWP Operations BO) could change determination statements presented in the San Joaquin River Restoration Program (SJRRP) Programmatic Biological Assessment (BA) regarding effects of the Proposed Action at a 2005 level of development (LOD) on listed fish species: Chinook salmon, steelhead, delta smelt, longfin smelt, and green sturgeon.

The CalSim simulations conducted in support of the BA and Draft Program Environmental Impact Statement/Report (PEIS/R) were performed in advance of the release of the 2008 USFWS CVP/SWP Operations BO and 2009 NMFS CVP/SWP Operations BO. These BOs contain a number of RPAs that have the potential to significantly impact both CVP and SWP project operations and operations of other, non-CVP or non-SWP facilities. Reclamation identified the need to reevaluate the Proposed Action with the inclusion of these BOs to evaluate the potential for the RPAs to significantly change the San Joaquin River tributary and Delta fisheries effects determination presented in the BA and level of significance of impacts presented in the Draft PEIS/R.

Currently, there is no agreed-upon representation in the CalSim II simulation model of implementation of the full set of RPAs. The U.S. Department of the Interior, Bureau of Reclamation (Reclamation) and NMFS continue to discuss the implementation of the RPAs, and the CVP/SWP operational implementation required to support the RPAs, into a singular CalSim II baseline, but no final baseline has been established. Therefore, sensitivity analyses were performed to support evaluation of the potential for a comprehensive range of RPA implementations to significantly change the San Joaquin River tributaries' or Delta fisheries' effects determinations from those presented in the BA.

The RPAs would not change effects related to vegetation or terrestrial wildlife, and would not change the effects of the program-level actions to fish and their habitat. Thus only effects on fisheries associated with project-level actions are discussed in this appendix.

The CalSim simulations for the sensitivity analyses were developed in an attempt to capture the range of potential operation change that could occur under any implementation scheme. The simulations were not refined in an attempt to develop "viable" or "reasonable" operations, meaning that potentially "unviable" or “unreasonable” operations were left in the simulations if they occurred. The final set of simulations defines an outer boundary of potential Proposed Action effects given the uncertainty in any final implementation of the RPAs or definition of “viable” or “reasonable” operations. These simulations were then used to define an outer boundary of potential fisheries’ effects of implementing the Proposed Action under any final implementation of the RPAs. They are not intended to represent Reclamation-suggested RPA implementations or Reclamation policy in any form. Use of these simulations outside of this sensitivity analysis does not represent Reclamation policy and may be misleading or factually incorrect.

2.0 Sensitivity Analysis Development

The sensitivity analysis was performed by developing a set of potential RPA scenarios. CalSim II was then used to simulate both the Baseline and Proposed Action under each of the RPA scenarios. The difference between the Baseline and Proposed Action under each RPA scenario was then evaluated to get impact calls. The effects determinations under each RPA were then compared to the effects determinations in the BA.

The sensitivity analysis was not developed to allow analysis of the difference between RPA scenarios. These differences are not caused by the Proposed Action; they are merely an outcome of the different assumed RPA implementation for each scenario. No comparisons were made between RPA scenarios in the analysis. Comparisons were made between the Baseline and Proposed Action within each RPA scenario to evaluate the potential effects of the Proposed Action within that RPA scenario. The effects were compared between RPA scenarios to see if the RPA scenario could produce a different effects determination than documented in the BA.

The uncertainty concerning representation of final implementation of the RPAs focuses on the San Joaquin River and the Stanislaus River. The RPAs considered for inclusion in this sensitivity analysis are selected to capture this uncertainty, and include the following RPAs from the 2009 NMFS CVP/SWP Operations BO:

- **RPA Action III**: **Introduction to Stanislaus River/Eastside Division Actions –** The BO specifies implementation of "VAMP-like flows" but gives no details on what these flows should be or how they would be implemented. Further complicating this issue is the fact that the current Vernalis Adaptive Management Program (VAMP) ends after 2011 and no new agreements have been reached to continue the current program. For the purpose of this sensitivity analysis the following three possible implementations are assumed:

    - No VAMP requirements or similar requirements.

    - Existing VAMP implementation from the version of CalSim used to support the PEIS/R and BA is imposed before other RPAs on the San Joaquin River and the Stanislaus River.

    - Existing VAMP implementation from the version of CalSim used to support the PEIS/R and BA is imposed after other RPAs on the San Joaquin River and the Stanislaus River.

- **RPA Action III.1.2**: **Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures –** At the present time there is speculation to explore developing a flow surrogate for this requirement. For the purposes of this sensitivity analysis it is assumed that flow requirements on the Stanislaus River will meet Stanislaus temperature requirements, and therefore this parameter is not explicitly modeled.

- **RPA Action III.1.3: Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam –** The issue with these flow requirements on the Stanislaus River centers on the way the requirements are imposed within other requirements on the same river system and not on the magnitude of the flows. For the purposes of this sensitivity analysis, the standards are imposed but varied to be the first flow requirements imposed or the last flow requirements imposed.

- **RPA Action IV.2.1: San Joaquin River Inflow to Export Ratio –** These are specified in the 2009 NMFS CVP/SWP Operations BO as an initial Phase I version and a later, more stringent Phase II. Because the sensitivity analysis is being performed to evaluate the outer boundary of potential fisheries effects of implementing the Proposed Action under any final implementation of the RPAs, the more stringent Phase II RPA implementation is used in all simulations.

- **RPA Action IV.2.3: Old and Middle River Flow Management –** The reverse Old and Middle rivers (OMR) flow requirements vary based on a number of real-time variables that cannot be modeled, such as the presence of fish at specific locations. There has been considerable work expended to develop a surrogate approach to implementing the variable OMR flow requirements, which has resulted in a single possible implementation that is believed to be a reasonable representation of conditions expected to prevail over an extended time frame. For the purposes of this sensitivity analysis, this single implementation is maintained in all simulations.

- **CVP Operations: Stockton East Water District Allocation –** There is disagreement on whether Stockton East Water District should receive its full contract amount of water each year or a variable amount based on available water supply.

The sensitivity analyses were performed based on the baseline conditions and the Proposed Action (equivalent to the Existing Condition and Alternative A1 with a 2005 LOD, as presented in the Draft PEIS/R) with the six possible RPA scenarios shown in Table 1. Of the action alternatives presented in the Draft PEIS/R, Alternative A1 includes the greatest potential change in San Joaquin River Delta inflows and would therefore have the greatest potential for change under the new RPAs.

Reclamation provided a 2005 LOD version of CalSim II with all the RPAs from the 2008 USFWS CVP/SWP Operations BO and the 2009 NMFS CVP/SWP Operations BO. The RPA implementation in this version of CalSim is documented in Attachments 1 and 2. This version of CalSim was then modified as required to implement the potential RPA implementations required for this analysis. These modifications are documented in Attachment 3.

Table 1.
RPA Scenarios Included in the Sensitivity Analyses

<table>
<tr><th>RPA Scenario</th><th>Goodwin Flow Requirements[1]</th><th>Stockton East</th><th>VAMP-Like Flows[1]</th><th>Stanislaus Temperature</th><th>SJR E/I Ratio and Vernalis Minimum</th><th>OMR Flow</th></tr>
<tr><td>No RPA</td><td colspan="6">As Used in the Biological Assessment</td></tr>
<tr><td>1</td><td rowspan="3">First</td><td>Variable based on available water supply</td><td>None</td><td rowspan="6">Met through Stanislaus Flow Requirements</td><td rowspan="6">Phase II</td><td rowspan="6">As Specified</td></tr>
<tr><td>2</td><td>100% of contract amount</td><td>None</td></tr>
<tr><td>3</td><td rowspan="2">Variable based on available water supply</td><td>First</td></tr>
<tr><td>4</td><td>Last</td><td>First</td></tr>
<tr><td>5</td><td>First</td><td rowspan="2">100% of contract amount</td><td>First</td></tr>
<tr><td>6</td><td>Last</td><td>First</td></tr>
</table>

Note:
[1] Refers to the order in which this requirement is implemented on the Stanislaus River and/or San Joaquin River, relative to other RPA requirements.

Key:
% = percent
E/I = Export to Import
OMR = Old and Middle Rivers
RPA = Reasonable and Prudent Alternative
SJR = San Joaquin River

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3.0 Methodology

The following geographic subareas are included in the analyses and are described below:

- San Joaquin River Upstream from Friant Dam
- San Joaquin River Between Friant Dam and the Merced River
- San Joaquin River Between Merced River and the Sacramento-San Joaquin Delta (Delta)
- Delta

The fisheries analyses covers potential changes in effects (relative to those presented in the BA) to Chinook salmon, steelhead, delta smelt, longfin smelt, and green sturgeon in the Delta and to Chinook salmon and steelhead in the Merced, Tuolumne, and Stanislaus rivers. These evaluations compare the results derived in the sensitivity analyses for each of the six RPA scenarios to the results in the BA. The sensitivity results for the baseline conditions at a 2005 LOD are compared to the results of the Proposed Action at a 2005 LOD, and results of the baseline conditions in the BA are compared to the Proposed Action results in the BA. This difference is then used to identify if there could be a change in the effects determinations as stated in the BA.

3.1 San Joaquin River Upstream from Friant Dam

There are no listed fish species upstream from Friant Dam. Additionally, the RPAs would not affect the operations of Friant Dam or the San Joaquin River upstream from Friant Dam. As a result, there is no change to the effects determination to listed fish in the San Joaquin River upstream from Friant Dam, and therefore, this geographic subarea is not discussed further.

3.2 San Joaquin River Between Friant Dam and the Merced River

Although there are no listed fish that occur in the San Joaquin River between Friant Dam and the Merced River, there is a potential for steelhead to re-colonize the area if the Proposed Action is implemented. However, the RPAs would not affect the operations of Friant Dam or the San Joaquin River between Friant Dam and the Merced River. As a result, there is no change to the effects determination to listed fish in the San Joaquin River between Friant Dam and the San Joaquin River, and therefore, this geographic subarea is not discussed further.

3.3 San Joaquin River Between Merced River and the Delta

This section describes the method of determining the potential change in effects to steelhead and fall-run Chinook salmon in the San Joaquin River tributaries – the Merced, Tuolumne and Stanislaus rivers. The lower portion of the San Joaquin River, near Vernalis, is described in the Delta region.

Implementation of the RPAs has the potential to change the operations of the reservoirs on the tributary rivers, resulting in changes, both increases and decreases, in flow. This evaluation compares the flows from the BA to the flows from the sensitivity analysis to conclude whether or not flows change in a manner that could change the Chinook salmon and steelhead effects determination.

Flows on the tributaries are predominantly controlled by three factors:

- **Vernalis Water Quality Standard –** The Vernalis water quality standard is an electrical conductivity (EC) requirement of 700 and 1,000 micromhos/centimeter for the irrigation (April to August) and non-irrigation (September through March) seasons, respectively. If estimated EC does not meet the Vernalis water quality standard, releases are made from New Melones Reservoir on the Stanislaus River to mix with the San Joaquin River to meet the Vernalis Water Quality standard.

- **Vernalis Adaptive Management Program –** VAMP is an experimental and management program designed to protect San Joaquin River juvenile Chinook salmon as they migrate to and through the Delta. VAMP is also set up to determine how survival rates change in response to alterations in San Joaquin River flows and CVP/SWP exports with the installation of the Head of Old River Barrier. VAMP employs an adaptive management strategy to use current knowledge of hydrology and environmental conditions to protect Chinook salmon smolts, while gathering information to allow more efficient protection in the future. VAMP specifies a 31-day pulse flow during the 61-day window of April and May to coincide with fish movement in the area. Because all three tributary rivers share the responsibility of meeting VAMP flow requirements, the increase in the San Joaquin River flows caused by Interim and Restoration flows could cause changes in operations on all three tributaries.

- **Local tributary operations –** The major reservoirs on the tributary rivers all operate for local requirements, including flood management and water supply. The rules governing operation of these reservoirs to meet these requirements are based on reservoir storage at any given time. For example, flood management rules typically require releases of specified storage limits. Reservoir storage at the start of the high inflow period dictates when a reservoir will reach the flood control storage limit, thus changing releases made from the reservoir to meet flood management objectives.

Criteria for determining impacts to tributary fish in the BA were based on the flows in each tributary that are believed to provide the maximum habitat for each life stage of Chinook salmon and Central Valley steelhead. These flows, shown in Table 2, were identified by NMFS based on several sources, including instream flow incremental methodology studies conducted to calculate maximum weighted usable area of habitat for each life stage (USFWS 1993, 1995, 1997), California Department of Fish and Game's salmon model developed for the San Joaquin River, and studies conducted for Federal Energy Regulatory Commission (FERC) relicensing projects.

Table 2.
Tributary Flows Assumed to Provide Maximum Habitat

Time Frame	Life Stage	Flow (cfs)
Merced River Chinook Salmon/Steehead[1]		
October 1 – December 31	Spawning	400
January 1 – March 15	Incubation/fry rearing	400
March 16 – June 15	Juvenile Rearing/Migration	1,500
June 15 – October 31	Juvenile rearing/Adult (steelhead)	250
Tuolumne River Chinook Salmon[2]		
October 1 – April 30	Spawning/Incubation/Fry Rearing	275
February 1 – October 31	Juvenile Rearing	150
January 1 – June 30	Juvenile Migration	1,100
Tuolumne River Steelhead[2]		
January 1 – December 31	All life stages	275
March 15 – June 30	Juvenile Migration	1,100
Stanislaus River Chinook Salmon[3]		
October 15 – December 31	Spawning	300
January 1 – February 28	Incubation/Fry Rearing	300
February 15 – March 15	Juvenile Rearing	200
March 15 – June 30	Juvenile Migration	2,000
Stanislaus River Steelhead[3]		
November 1 – Feb 28	Spawning	200
January 1 – March 31	Incubation/Fry Rearing	200
January 1 – December 31	Juvenile Rearing	150
March 15 – June 30	Juvenile Migration	2,000

Sources: USFWS 1993, 1995, and 1997, DFG 2005, NMFS 2009

Notes:

[1] Because information is limited on steelhead, flows needed for Chinook salmon and steelhead are combined. Flows are based on information from the 1997 spawning habitat instream flow assessment and flow recommendations from the Anadromous Fish Restoration Program.

[2] Flows are based on the Stanislaus River Instream Flow Incremental Methodology report, and from results of the California Department of Fish and Game Chinook model.

[3] Flows are based on the Stanislaus River Instream Flow Incremental Methodology report, and from the NMFS 2009 Operations Criteria and Plan Biological Opinion – below-normal year

Key:

cfs = cubic feet per second

3.4 Delta

Factors identified in the BA as directly affecting fish (e.g., entrainment, predation, and food web support) are tied to five parameters related to San Joaquin River inflow and hydrodynamics in the south Delta. This sensitivity analysis only looks at the changes in the parameters caused by the Proposed Action under each RPA scenario. These parameters are:

- San Joaquin River Flows at Vernalis
- Old and Middle Rivers Flows
- Jones and Banks Diversions
- Ratio of San Joaquin River Flows at Vernalis to Old and Middle Rivers Flows
- Ratio of San Joaquin River Flows at Vernalis to Jones and Banks Diversions
- X2 Location

The Proposed Action is expected to have relatively little direct effect on most of the environmental conditions of potential importance to the listed Delta fishes, but is expected to change San Joaquin River inflows and hydrodynamics in the south Delta from baseline conditions. These changes may influence fish distributions in the Delta and thereby affect their distributions with respect to preexisting spatial variations in the environmental conditions. The south Delta is generally considered to have poor habitat conditions for most fish species relative to other parts of the Delta (Nobriga et al. 2008, Monsen et al. 2007, Feyrer 2004, Feyrer and Healey 2003). All the environmental conditions used to evaluate impacts on Delta fishes are generally less favorable in the south Delta than other parts of the Delta, and entrainment risk is much higher in the south Delta because of the large volumes of water exported by the Jones and Banks diversions. Therefore, hydrologic conditions that increase the likelihood that fish would occur in the south Delta or increase the time fish spend there are considered to adversely affect the fish.

San Joaquin River inflow and Jones and Banks diversions jointly affect the net flow patterns in the San Joaquin River side of the Delta, thereby influencing how fish are distributed with respect to the south Delta and how long the fish remain there (NMFS 2009, Kimmerer and Nobriga 2008, Monsen et al. 2007, Feyrer and Healey 2003, Mesick 2001). The Jones and Banks diversions export such large volumes that water often flows upstream in channels leading away from the pumps. This is most notable at Old and Middle rivers, and is referred to as reverse flows (Monsen et al. 2007). Reverse OMR flows result in greater salvage (Grimaldo et al. 2009) and entrainment (Kimmerer and Nobriga 2008) of delta smelt and Chinook salmon. Increased San Joaquin River inflow and reverse OMR flows generally have counteracting effects on the distribution of fish.

These flows are also likely to indirectly affect upstream migrating adult fish, with high reverse OMR flows leading to increased straying away from the main channel of the San Joaquin River towards the south Delta (USFWS 2008, Kimmerer and Nobriga 2008, Mesick 2001).

As described in the BA, the expected effects of Proposed Action on south Delta hydrodynamics were quantified using CalSim II operations model predictions of San Joaquin River flow at Vernalis (inflow), combined OMR flow, and total Jones and Banks diversions. The ratios of San Joaquin River inflow to OMR flow and of San Joaquin River inflow to Jones and Banks diversions were used evaluate the net effect of the parameters. Increases in the ratios were considered to reduce the probability of fish entering or remaining in the south Delta. The effect of the SJRRP on X2 was also examined to evaluate effects of the Proposed Action on Delta fishes beyond the south Delta.

The effects of the Proposed Action under the six RPA scenarios on listed Delta fish species were compared with the effects reported in the BA by examining changes in the six simulated hydrologic parameters and parameter ratios discussed above. Specifically, for each of the six RPA scenarios, changes from baseline conditions in average values of the six simulated hydrologic parameters and parameter ratios were compared with the corresponding changes reported in the BA. For OMR flow and the ratio of San Joaquin River inflow to OMR flow, the means were computed after excluding months and years with positive (i.e., not reversed) OMR flow because such conditions do not move fish toward the south Delta. Except during the winter and spring of Wet year types, OMR flow is almost always negative. Also, for the ratio of San Joaquin River flow to OMR flow, ratios greater than 5 were excluded from the mean values because fish are not moved toward the south Delta when this ratio is high, and including such high ratios would have potentially skewed the mean values. The comparisons between the RPA scenarios and BA are presented in graphs shown later in this document as Figures 1 through 6. Except for X2, they show the percent changes from baseline conditions for all water types. For X2, the changes are expressed as kilometers of upstream movement rather than percentages. The graphs also show the percentage of years in which changes from baseline conditions exceeded 10 percent (increase or decrease, depending on the parameter), or, for X2, exceeded 1 kilometer of upstream movement.

The assessment focuses on the February-through-June period because, as described in the BA, this period largely encompasses the spawning, larval rearing, and juvenile downstream migration periods of the selected fish species.

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4.0 Results and Conclusions

Results and conclusions of the sensitivity analysis for the listed fish species are presented below.

4.1 San Joaquin River Between Merced River and the Delta

Reservoir releases in the Merced, Tuolumne, and Stanislaus rivers in response to flow requirements at Vernalis and the Vernalis water quality standard are affected by tributary-specific operational requirements, including flood management and water supply. The Stanislaus Operations Group was established as a tool to allow NMFS and Reclamation to hear advice and recommendations and to discuss upcoming operations related to river conditions. This group determines whether additional flow needs to be released from New Melones Dam to meet the Vernalis water quality standard. This group also works with the Water Operations Management Team to meet fisheries needs in the Stanislaus River.

Changes in flows in the RPA scenarios in the San Joaquin River tributaries and associated Chinook salmon and steelhead habitat are nearly identical to the changes in flows in the No RPA scenario under all potential hydrologic conditions. Tables of the flows for each tributary are presented in Attachments 4 through 8.

Flows in the tributaries almost always either meet the target flows or, if not, then do not differ substantially in the No RPA scenario or the RPA scenario comparisons. Flow trends in the tributaries under the RPA scenarios are as follows:

- **Merced River –** For all life stages of Chinook salmon and steelhead, there are no differences in meeting the flow requirements between the RPA scenario and the No RPA scenario.

- **Tuolumne River –** For each species and life stage, there are no differences in meeting the flow requirements between the RPA scenarios and the No RPA scenario.

- **Stanislaus River –** For both Chinook salmon and steelhead in all life stages, there are no differences in meeting the flow requirements between the RPA scenarios and the No RPA scenario.

For the reasons described above, under the RPA scenarios, there would be no change in effects determinations for steelhead and fall-run Chinook salmon in the Merced, Tuolumne, and Stanislaus rivers relative to the No RPA scenario (Table 3).

Table 3.
Summary of the Changes in Effects for the Proposed Action Under Each RPA Scenario

RPA Scenario	Merced River Steelhead	Merced River Chinook Salmon	Tuolumne River Steelhead	Tuolumne River Chinook Salmon	Stanislaus River Steelhead	Stanislaus River Chinook Salmon
BA (no RPAs)	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect	No Effect	No Effect	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Scenario 1	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 2	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 3	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 4	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 5	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 6	No Change	No Change	No Change	No Change	No Change	No Change

Key:
BA = Biological Assessment
RPA = reasonable and prudent alternative

4.2 Delta

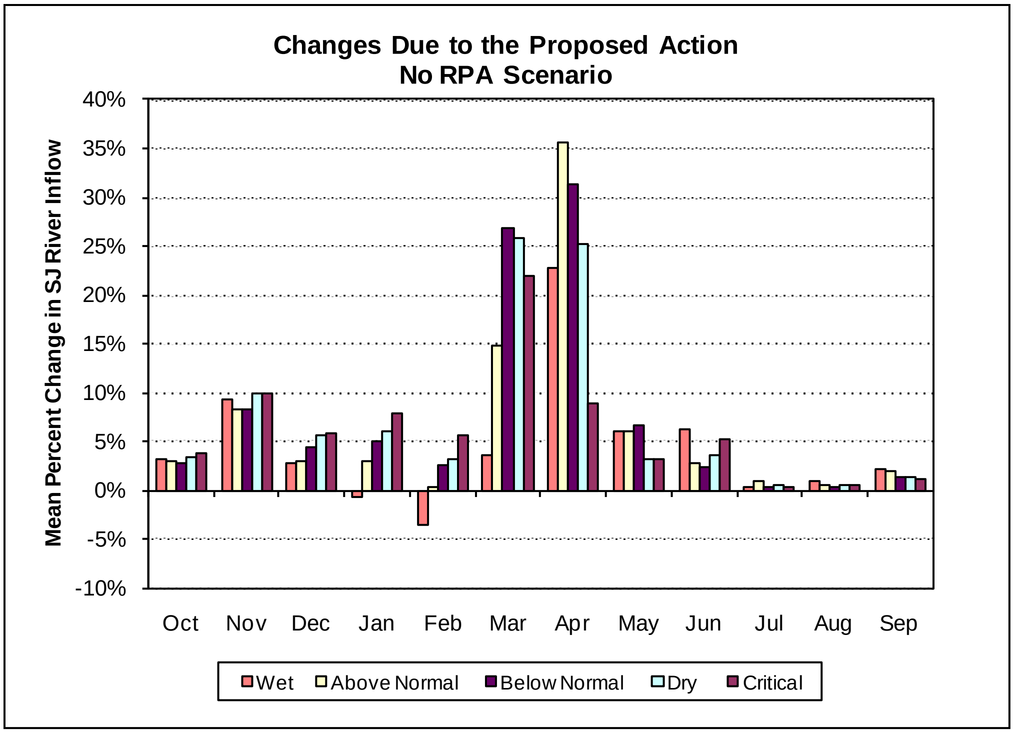
Potential changes in the effects determinations for Delta fisheries were assessed by evaluating changes between the baseline condition and the Proposed Action in the following parameters:

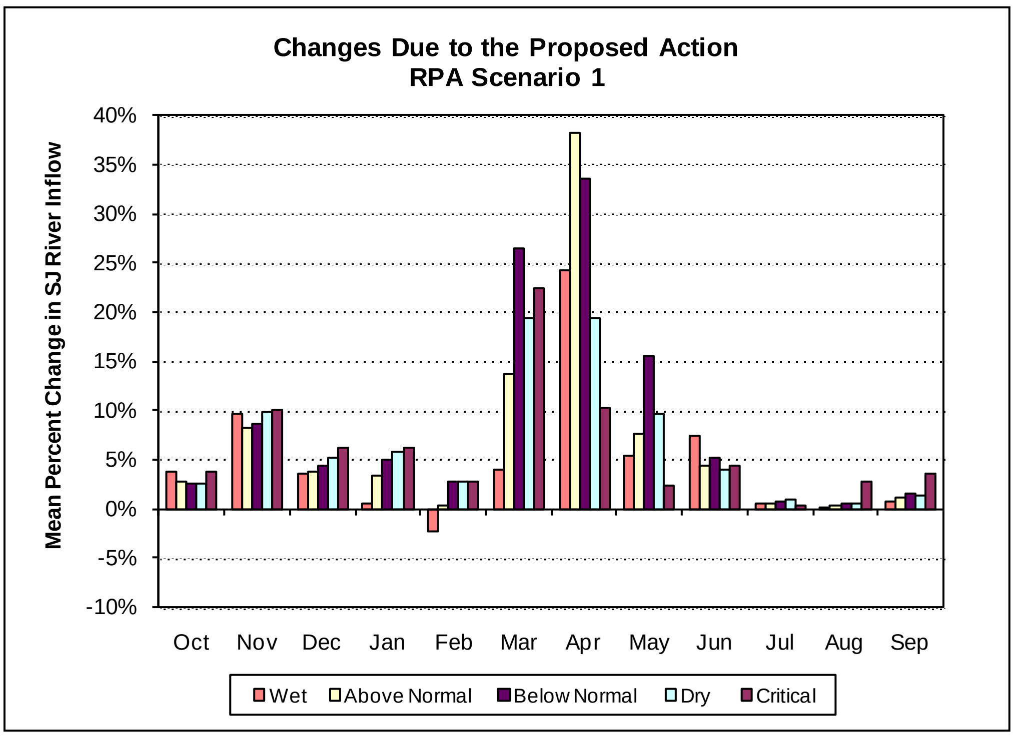
- San Joaquin River flow at Vernalis
- OMR Flows
- Jones and Banks diversions
- Ratio of San Joaquin River flows at Vernalis to OMR flows
- Ratio of San Joaquin River flow at Vernalis to Jones and Banks diversions
- X2 location

4.2.1 San Joaquin River Flows at Vernalis

For most of the hydrologic parameters analyzed, the changes in effects under the RPA scenarios were similar to the changes under the No RPA scenario. Changes in San Joaquin River flow at Vernalis under the six RPA scenarios are similar to the changes in the No RPA scenario (Figure 1 and Table 4). The most consistent differences are greater increases in May of Above Normal (AN), Below Normal (BN), and Dry water years in the RPA scenarios. Increases in San Joaquin River flow are also greater for May of Critical years with RPA scenarios 5 and 6 (Figure 1). Increases in San Joaquin River flow are reduced in April of AN and BN years in RPA scenarios 3, 4, and 5 and in April of AN and Dry years for RPA scenario 6.

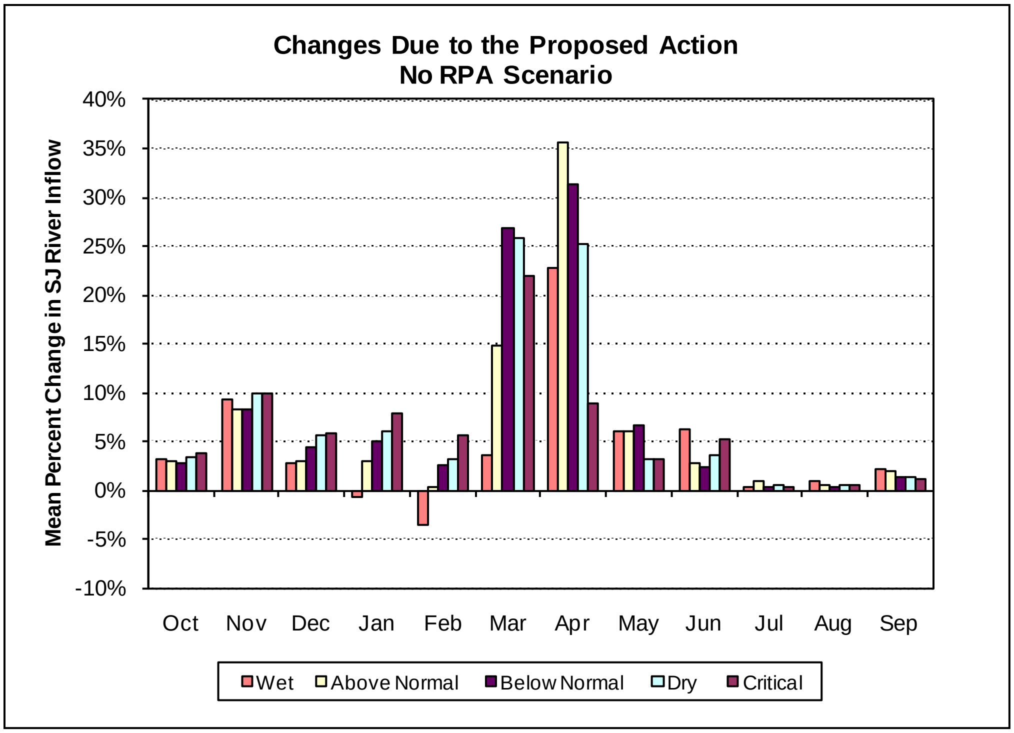
The percentage of years with more than a 10-percent reduction in San Joaquin River flow was similar for all RPA scenarios. In February, more than 8 percent of years resulted in greater than 10-percent flow reductions under each RPA scenario. With the RPA scenarios, all months had less than 5 percent of years with greater than 10-percent reductions in San Joaquin River flow (Table 4).

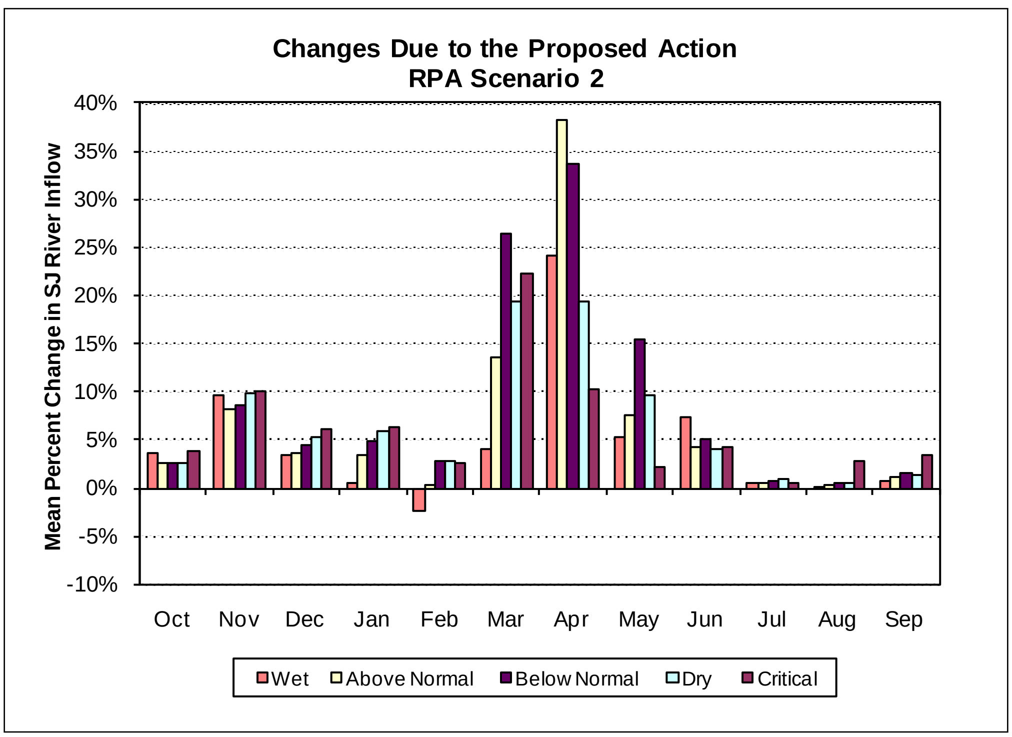




Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

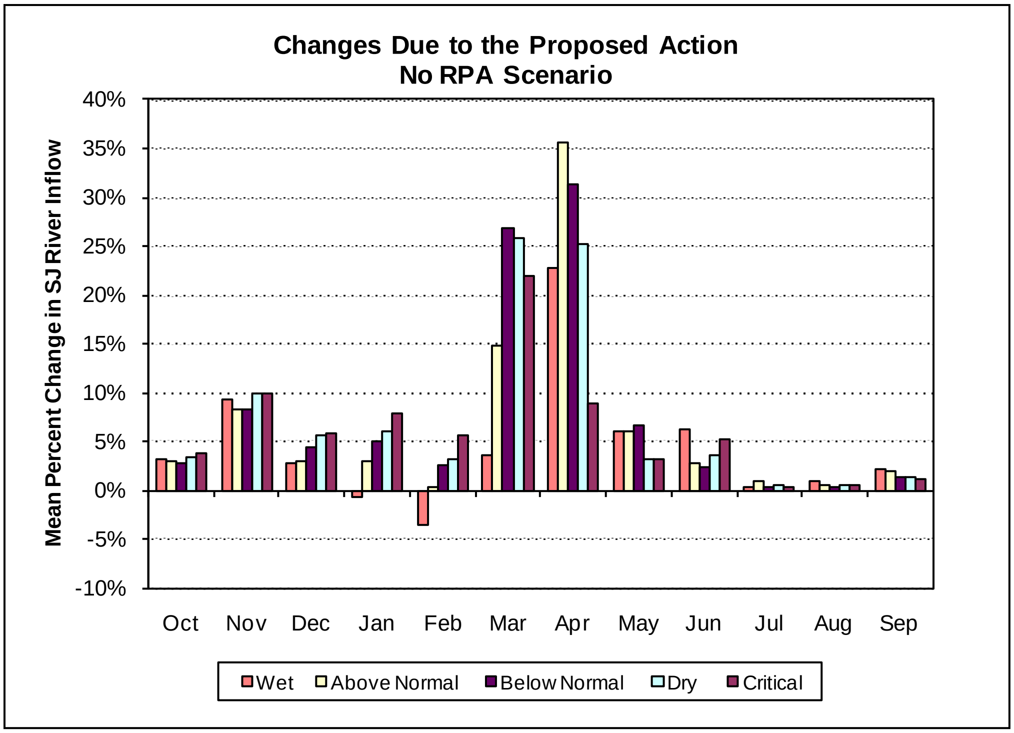
Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis

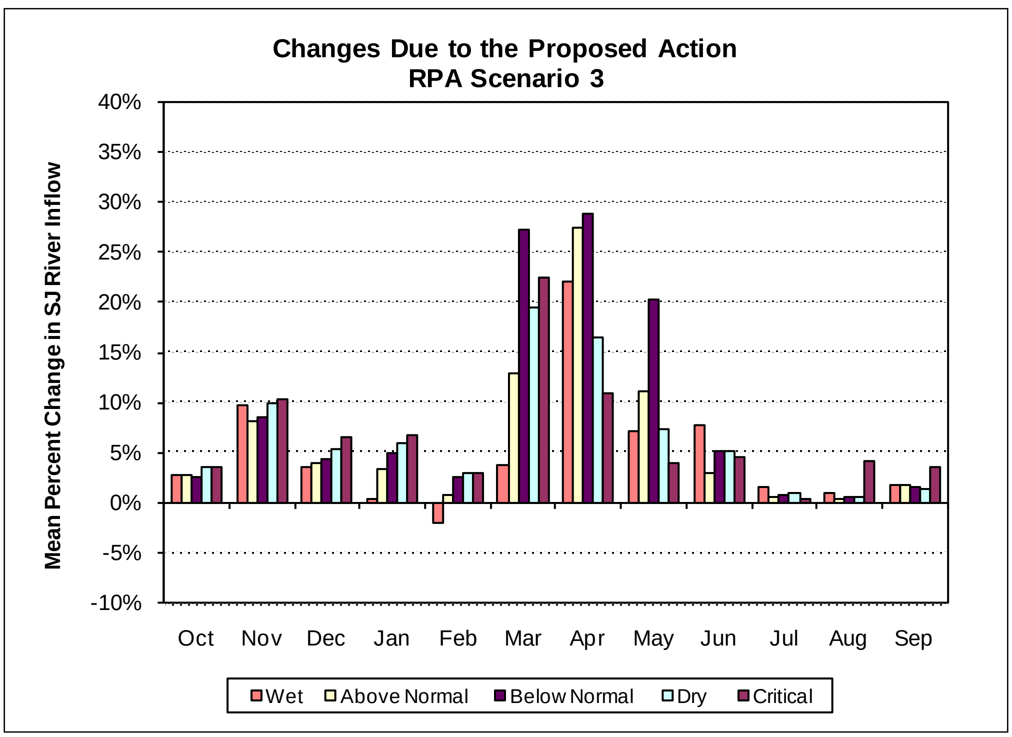




Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

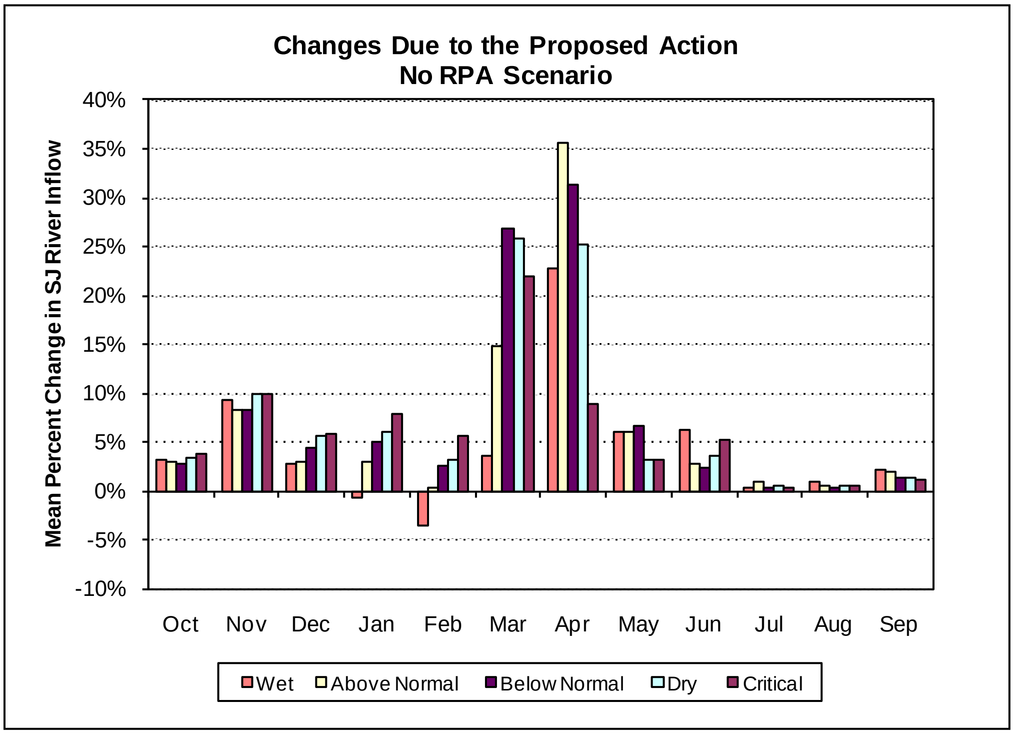
Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis (contd.)

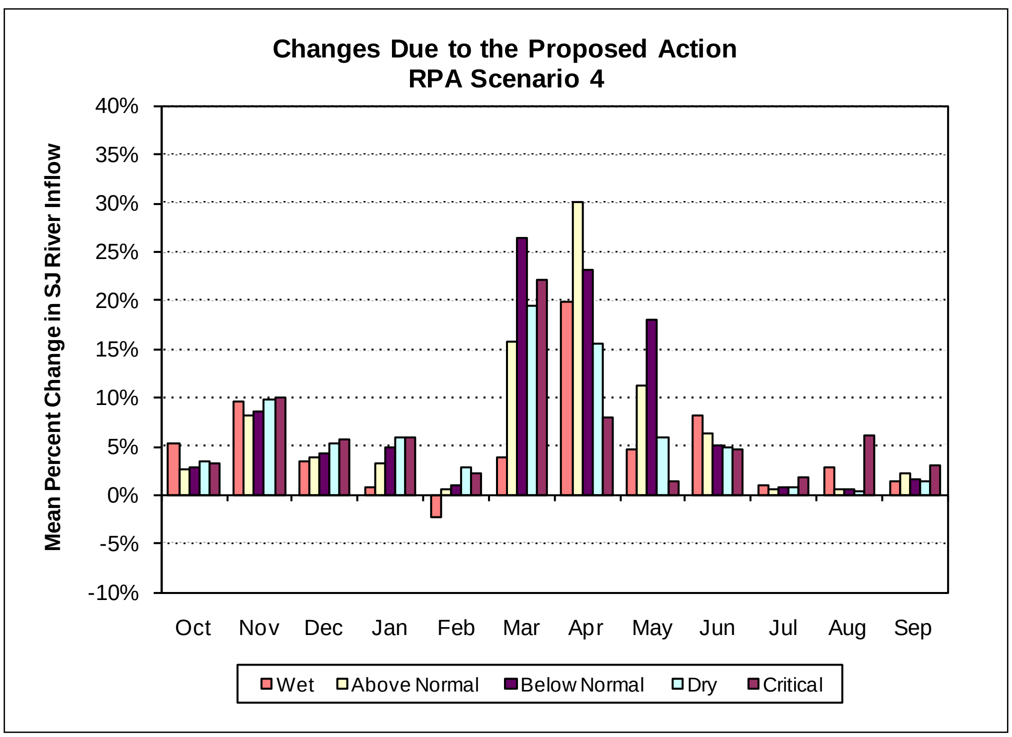




Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

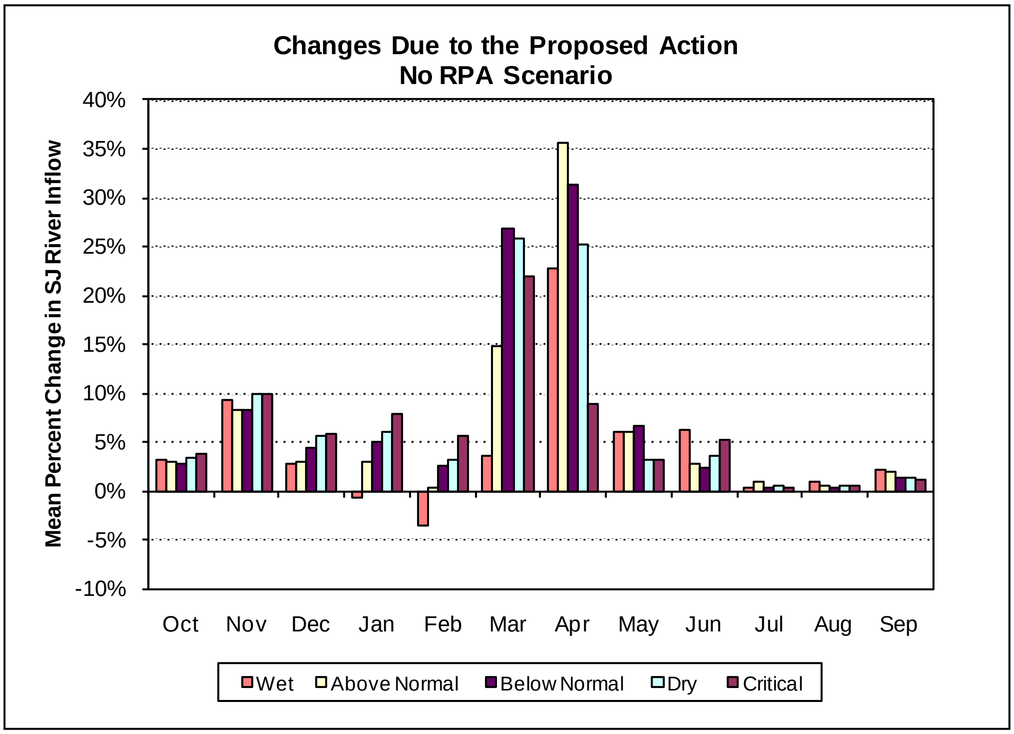
Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis (contd.)

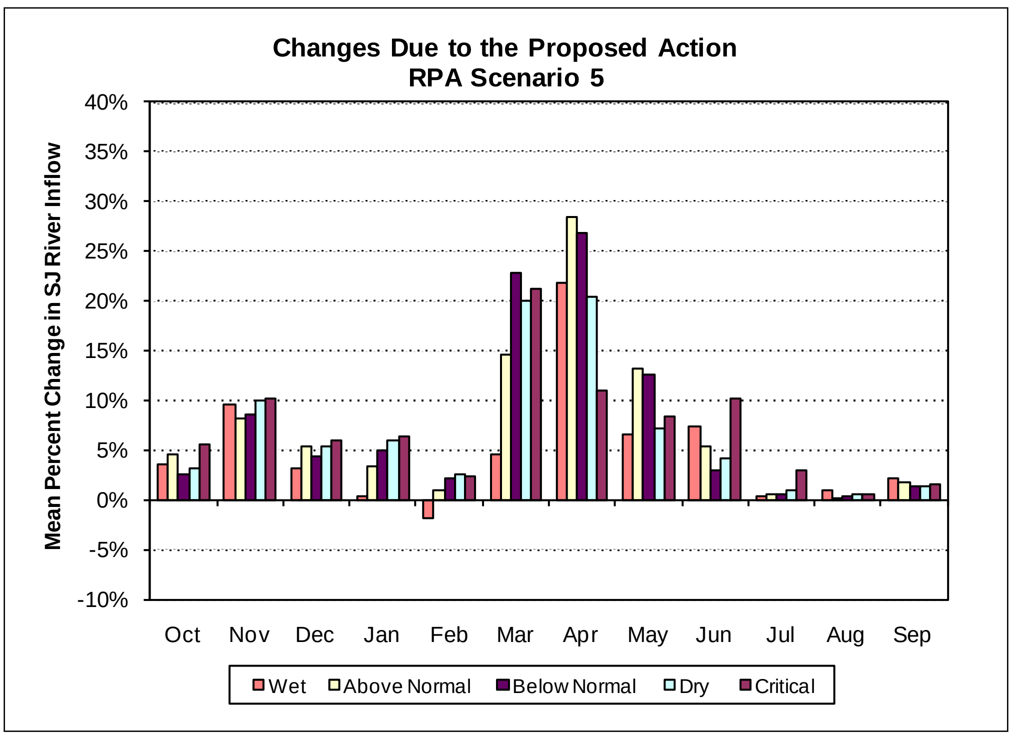




Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

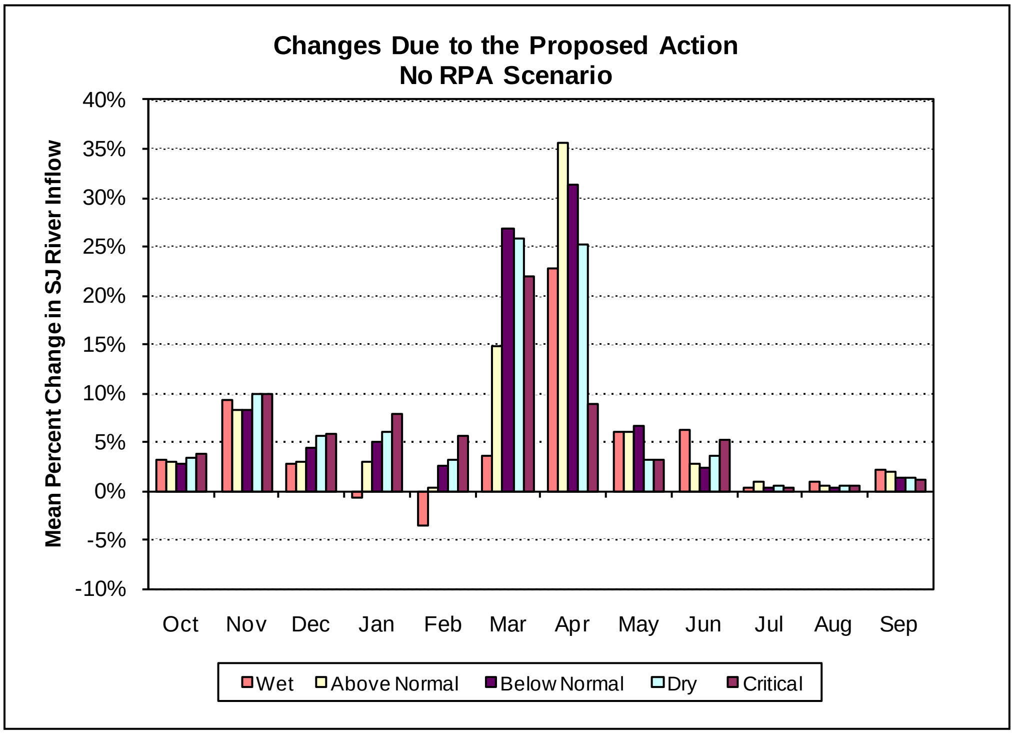
Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis (contd.)

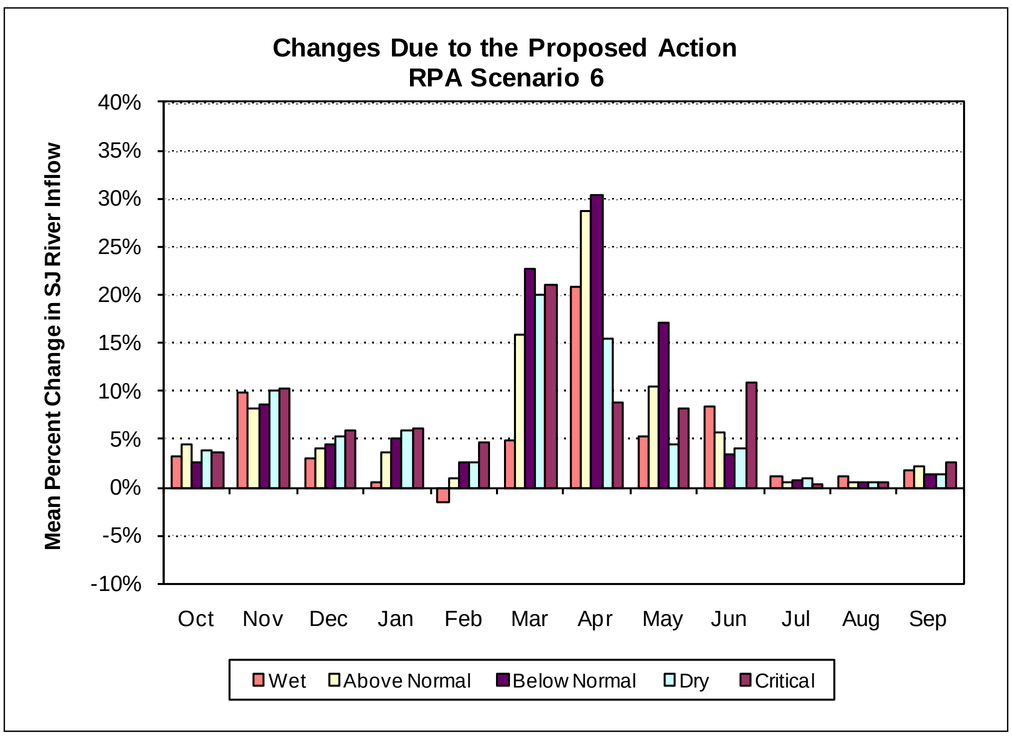




Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis (contd.)





Key:
RPA = reasonable and prudent alternative
SJR = San Joaquin River

Figure 1.
Mean Percent Changes in San Joaquin River Flow at Vernalis (contd.)

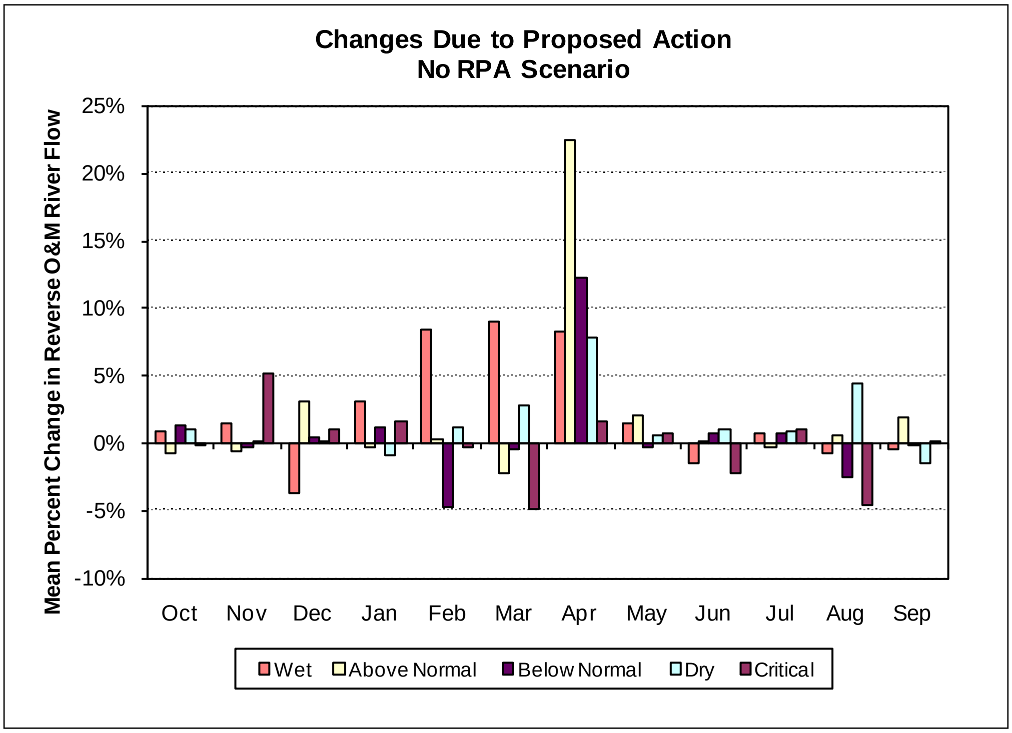
Table 4.
Percentage of Years for Which San Joaquin River Flows Decreased by More than 10 Percent

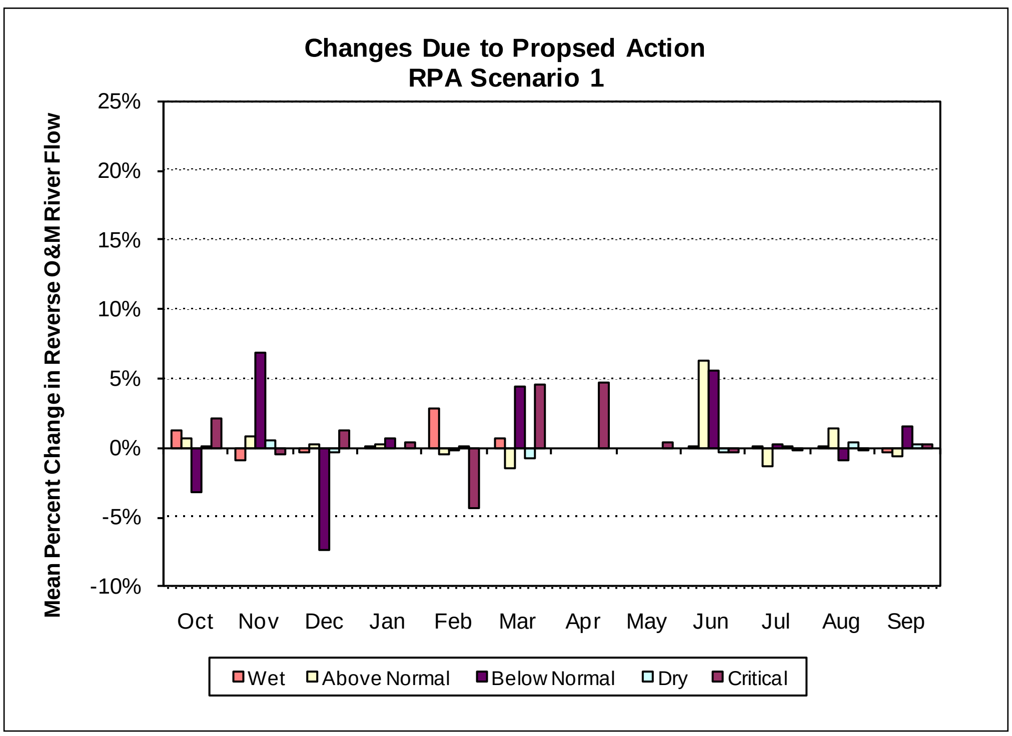
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	0	0	2	4	9	0	0	1	0	0	0	0
RPA 1	0	0	0	1	2	0	0	1	0	0	0	0
RPA 2	2	2	1	2	5	2	0	0	6	0	2	6
RPA 3	1	0	0	1	5	0	0	1	0	0	0	0
RPA 4	0	0	0	1	4	0	1	2	0	0	0	0
RPA 5	0	0	0	1	5	0	0	1	0	0	0	0
RPA 6	0	0	0	1	4	0	0	1	0	0	0	0

4.2.2 Old and Middle River Flows

Reverse OMR flows was the parameter that showed the most difference between the No RPA scenario and the RPA scenarios (Figure 2 and Table 5). This result occurs in part because many of the RPAs are directed at reducing reverse OMR flows. The differences were greatest for April and May, which are important months for delta smelt and longfin smelt. In RPA scenario 1, the reverse flows were much reduced in May of AN, BN, and Dry years, while the reverse OMR flows changed very little in May of all year types (Figure 2). Reverse OMR flow was much lower in April of Dry years for RPA scenario 1 and in April of BN and Dry years for RPA scenario 2, while it increased in April of all year types for the No RPA scenario. RPA scenarios 2, 4, 5, and 6 had large reductions in reverse OMR flows in April of BN and Dry years. Greater increases in reverse OMR flow were seen in May of BN years, in June of AN years in RPA scenarios 2, 4 and 5, and in June of AN years for RPA scenarios 1, 3 and 6.

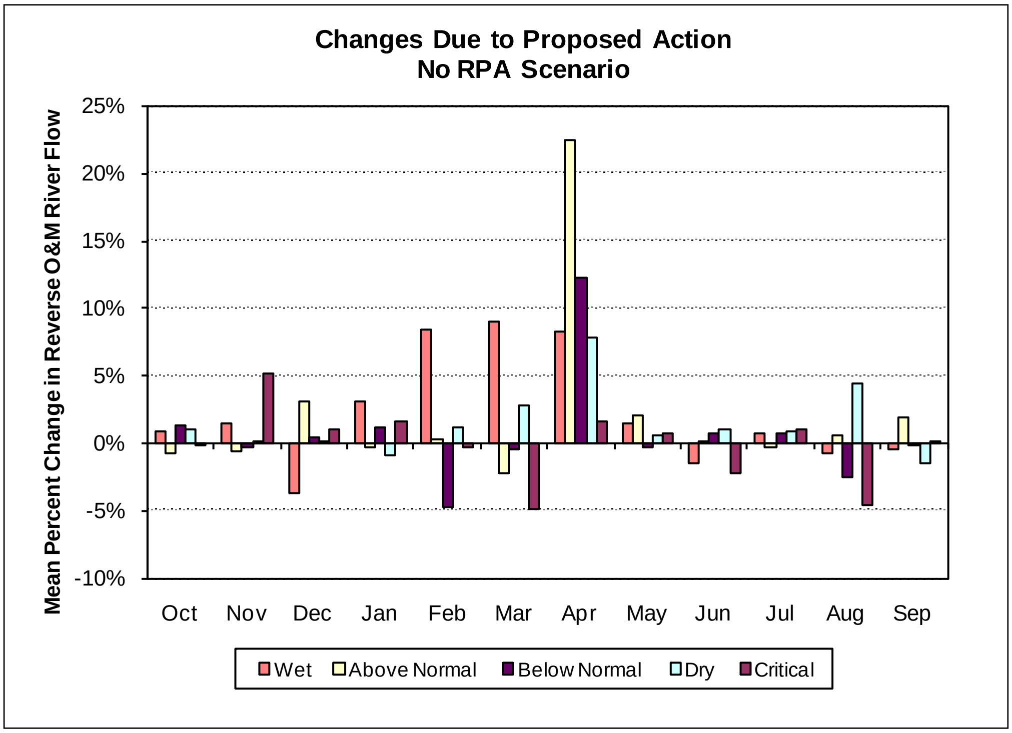
The percentage of years in which reverse OMR flows increased (i.e., became more negative) by more than 10 percent was similar in the RPA scenarios (Table 5). However, the results for April were substantially different. For April in the RPA scenarios, reverse flows increased by more than 10 percent in 15 percent or less of the years. In the No RPA scenario, the April percentage increased more than 10 percent in 40 percent of years.

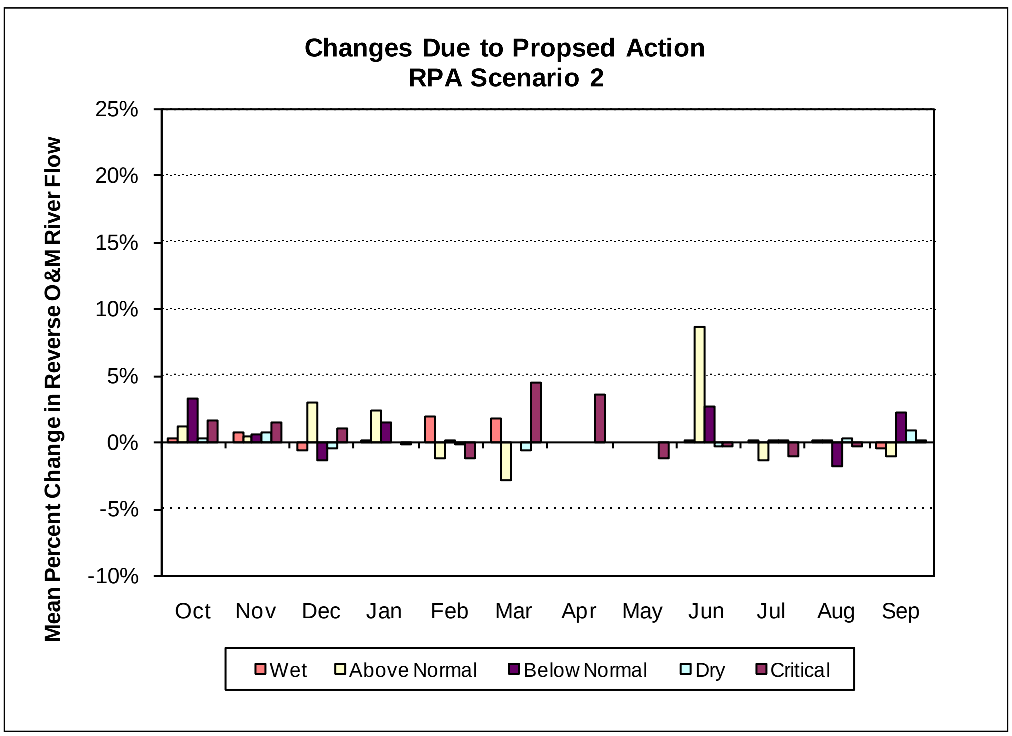




Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

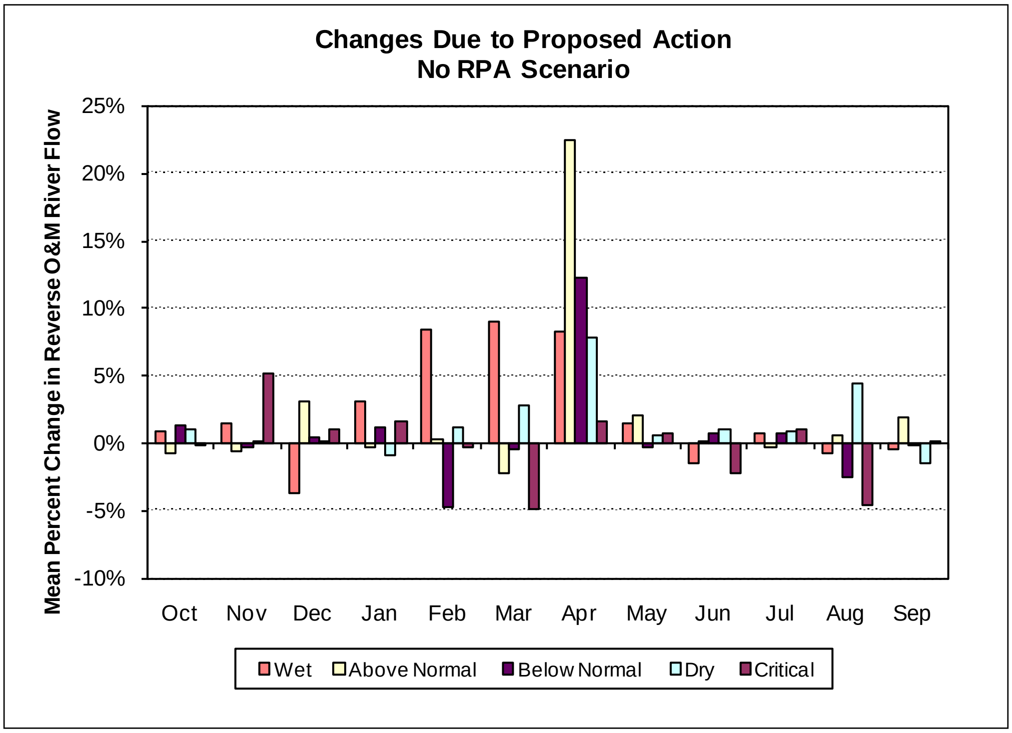
Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow

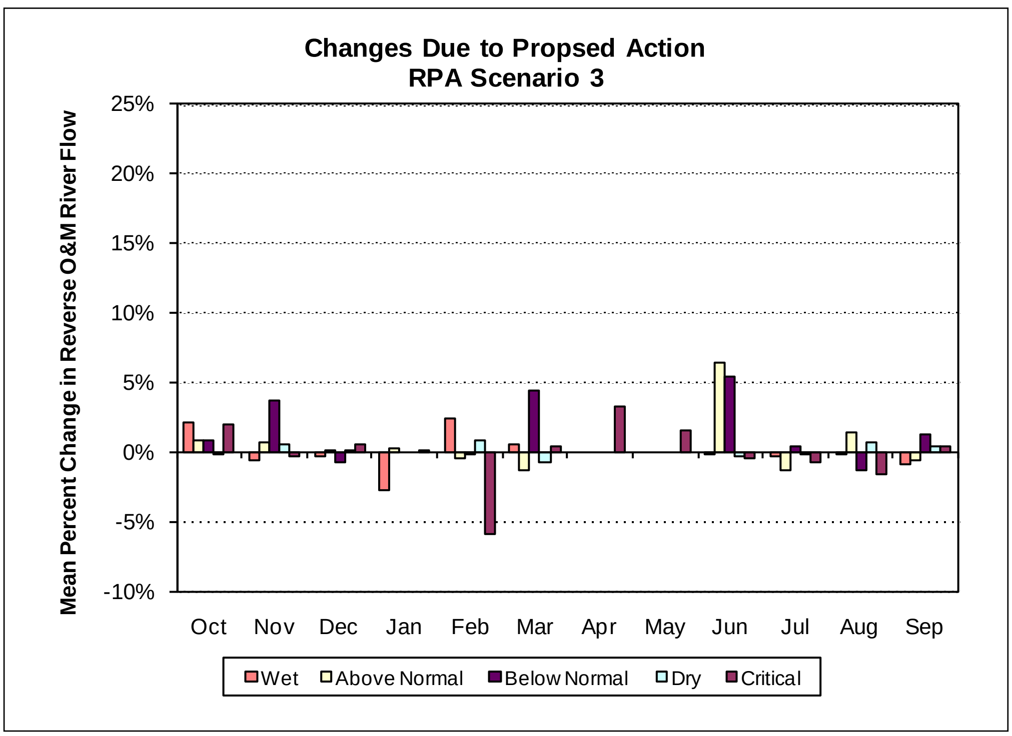




Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

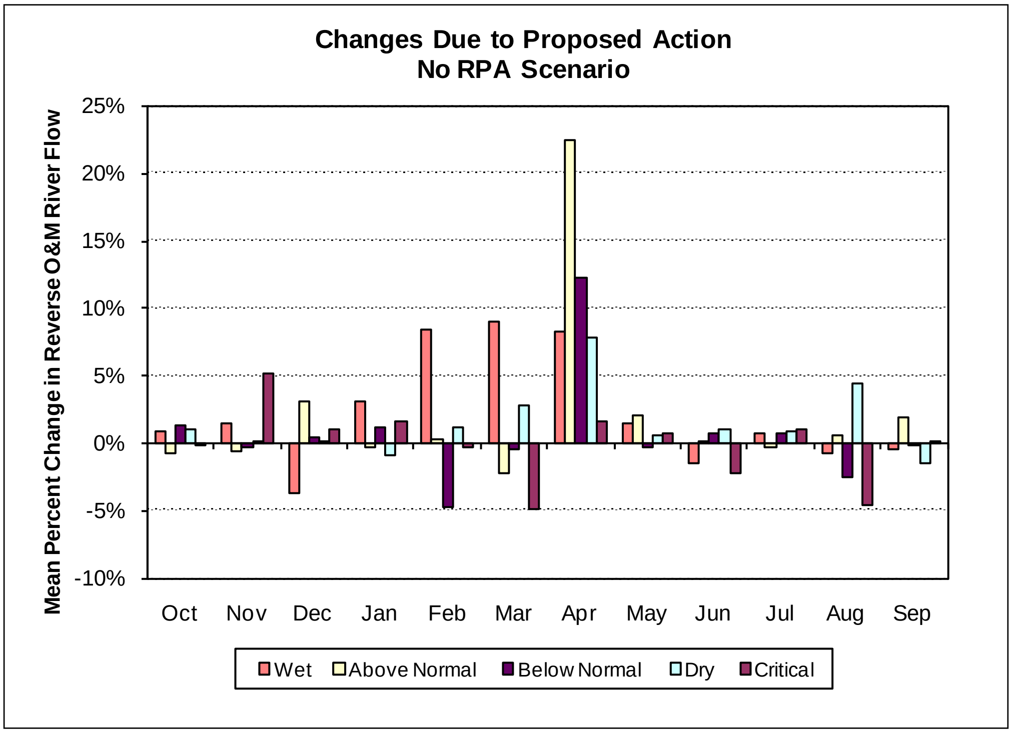
Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow (contd.)

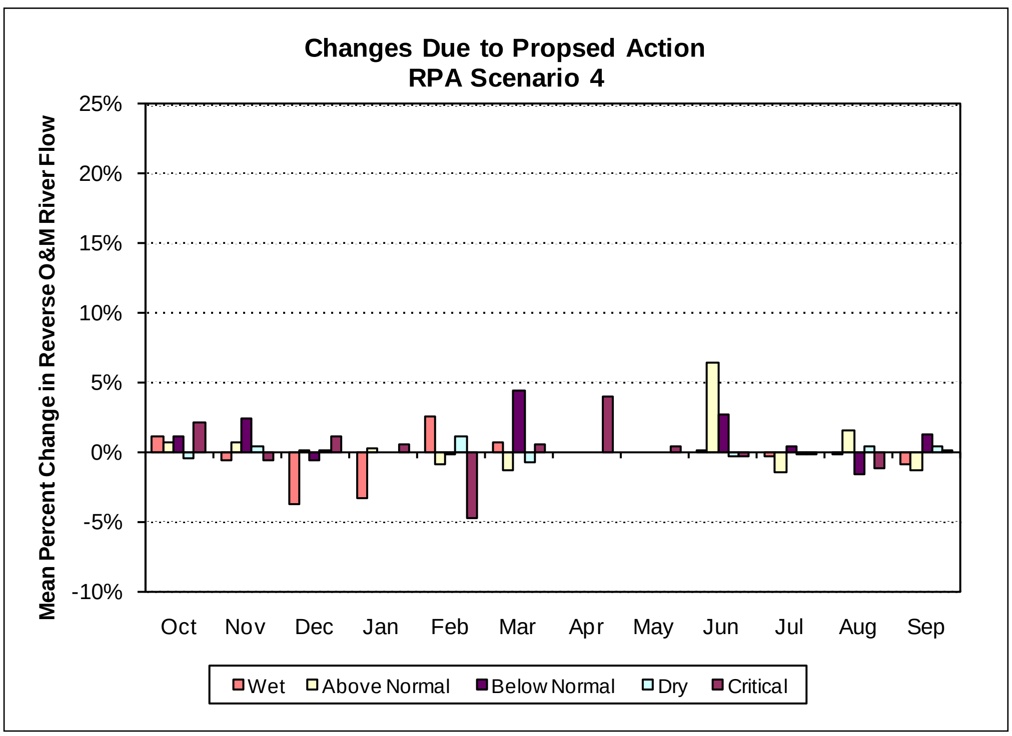




Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

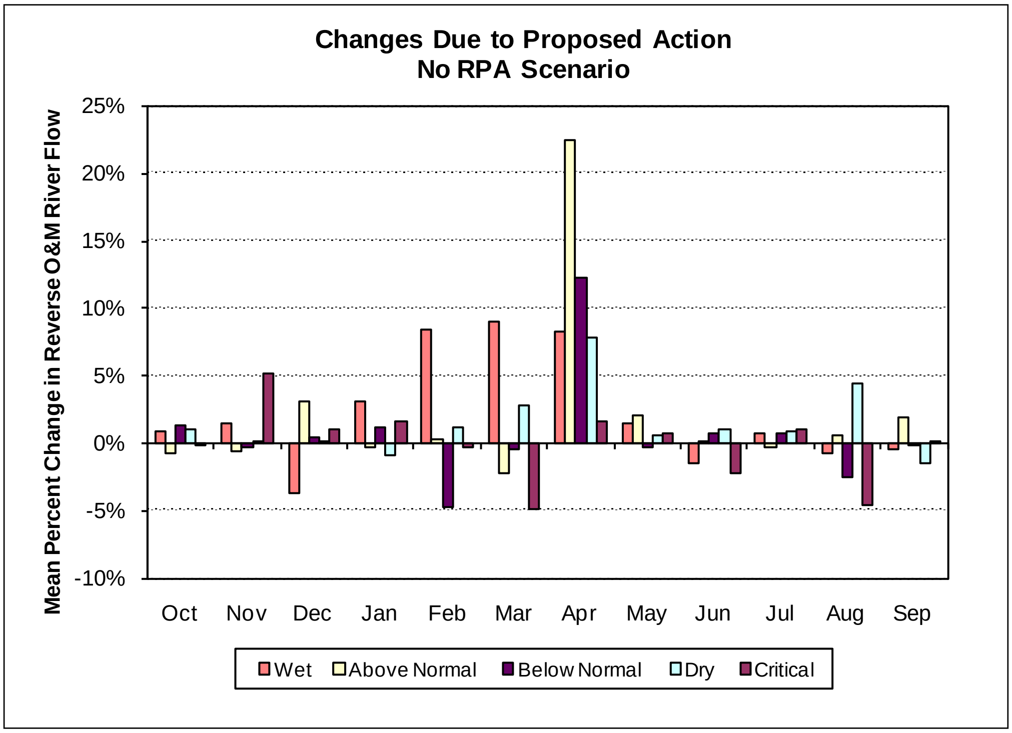
Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow (contd.)

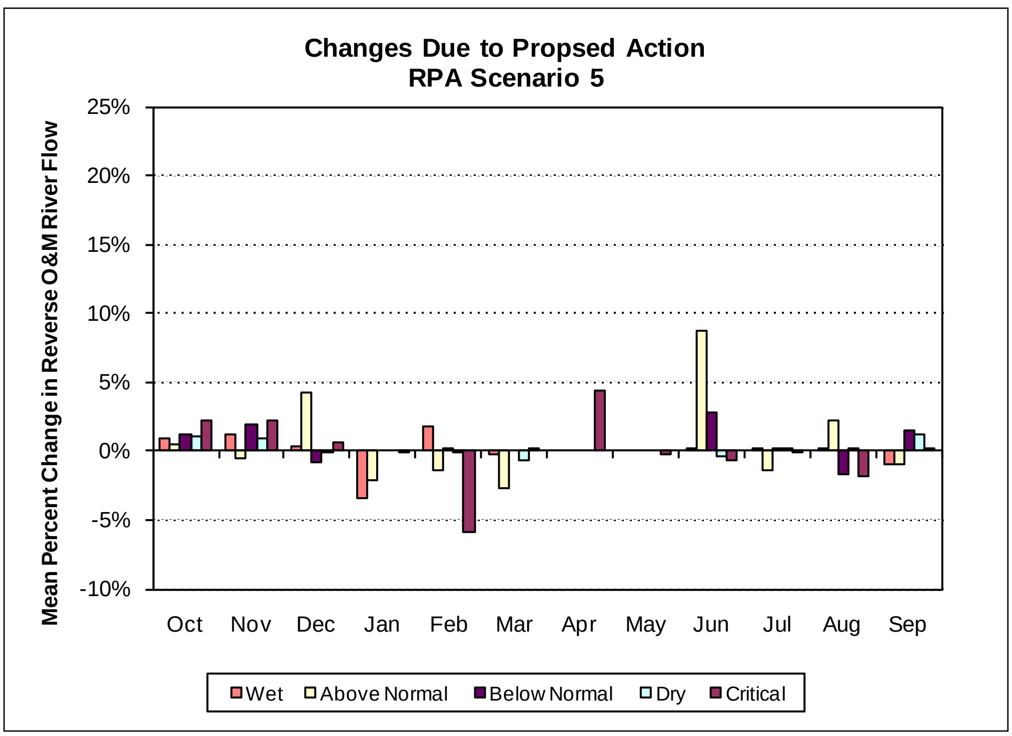




Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

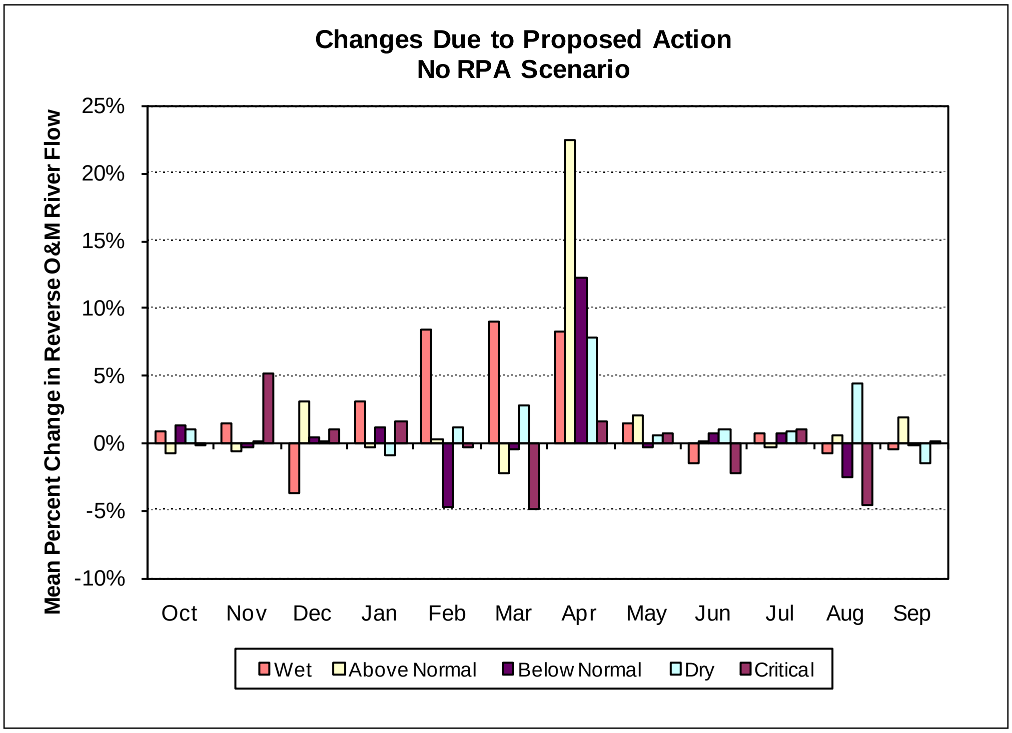
Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow (contd.)

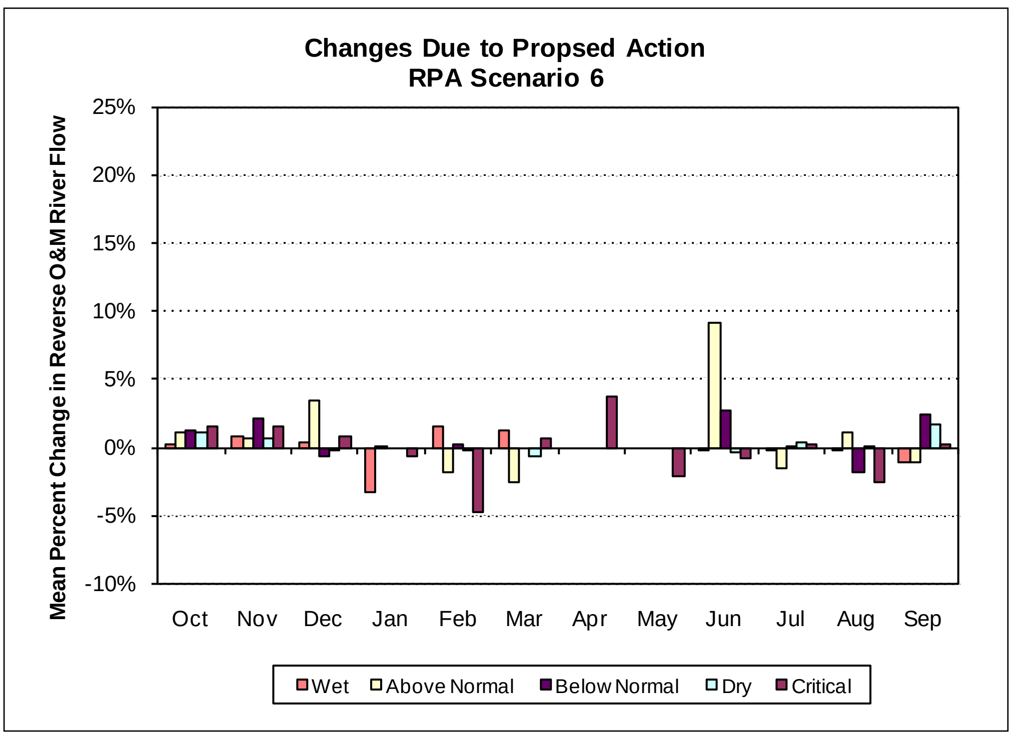




Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow (contd.)





Note: All positive flows excluded and reverse OMR flows given positive sign
Key:
OMR = Old and Middle River
RPA = reasonable and prudent alternative

Figure 2.
Mean Percent Changes in Old and Middle River Reverse Flow (contd.)

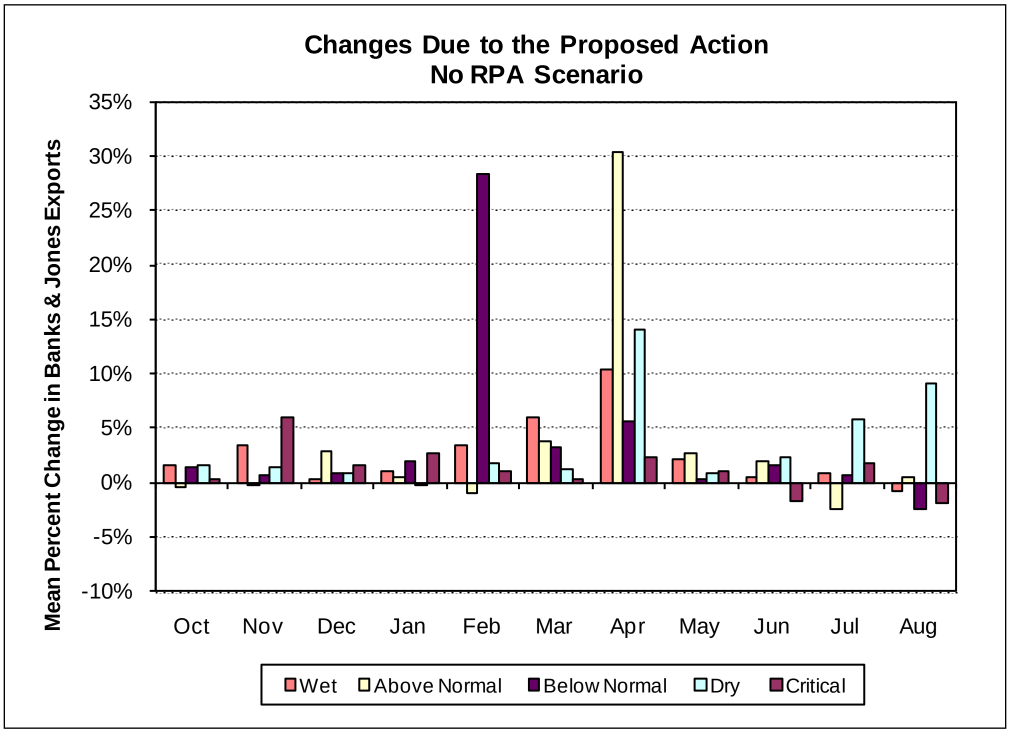
Table 5.
Percentage of Years for Which Reverse Old and Middle Rivers Flows Increased by More than 10 Percent

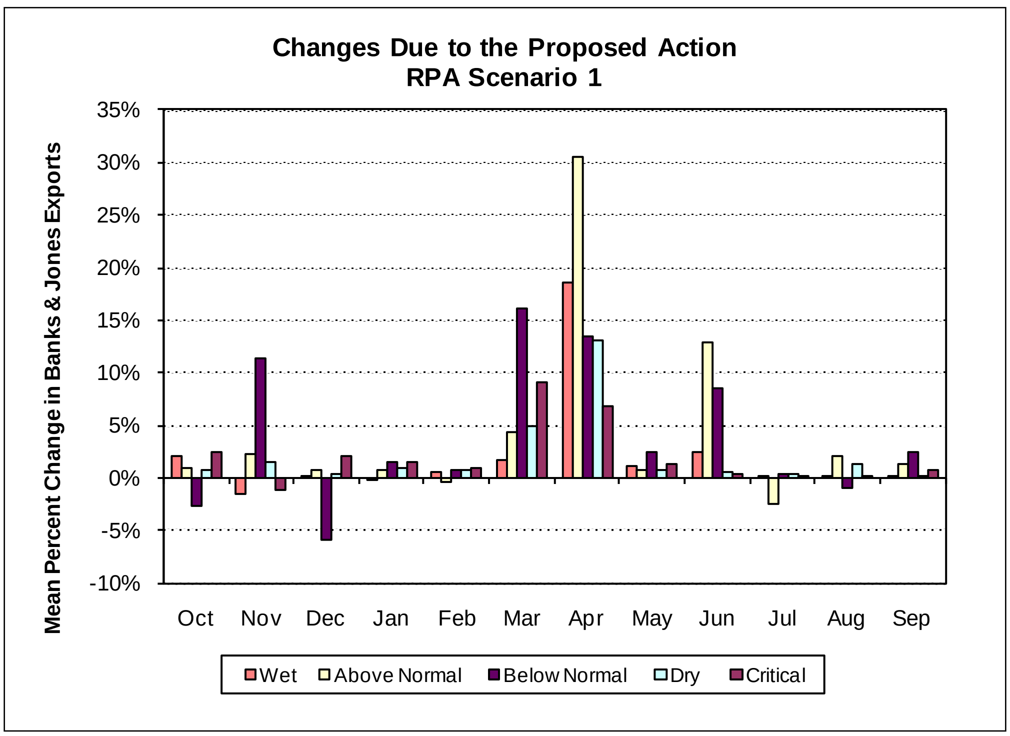
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	5	4	9	13	15	17	40	2	9	6	4	2
RPA 1	2	9	1	1	5	6	33	0	6	1	4	6
RPA 2	4	7	4	1	5	4	27	0	8	0	4	6
RPA 3	6	6	3	1	5	4	11	0	6	0	2	7
RPA 4	5	4	1	1	7	4	11	0	6	1	2	5
RPA 5	6	5	4	0	4	1	20	0	8	0	2	6
RPA 6	1	4	4	0	5	3	20	0	8	1	1	6

4.2.3 Jones and Banks Diversions

Predicted changes in Jones and Banks diversions showed substantial differences in the RPA scenarios for several months (Figure 3 and Table 6). Except in Wet years, increases in diversions in March were greater in the RPA scenarios than in the No RPA scenario. April had slightly greater increases in diversions in the RPA scenario in Wet, AN, and Critical years, and slightly lower in BN and Dry years. For May, increases in the diversions were greater in the RPA scenarios in AN, BN, and Dry years. In June of BN years and, more especially, AN years, increases in diversions were consistently greater in RPA scenarios than for the No RPA scenario. One large difference in the No RPA scenario, a 23-percent increase in average diversions for February of Dry years, can be attributed to the results for 1 year of the 82 year period of record in which the simulated diversions increased 387 percent. When that particular result is excluded, the average for February of Dry years falls to 1.4 percent, well within the range of the averages for the other year types.

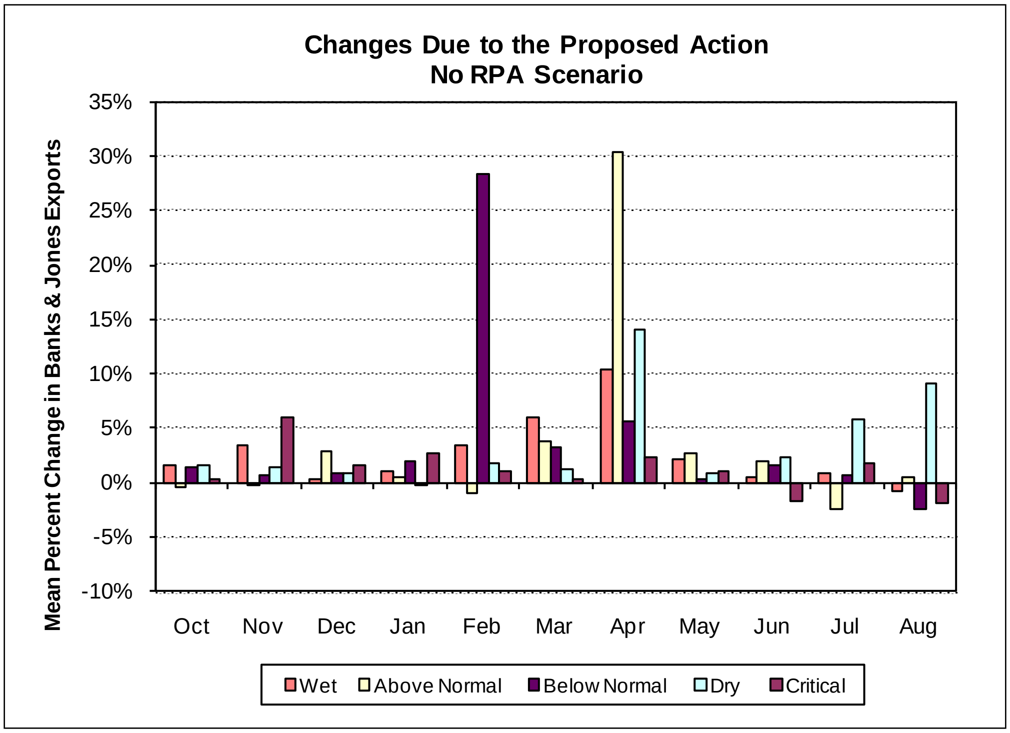
The percentage of years for which diversions increased by more than 10 percent was higher in April in the RPA scenarios than for No RPA scenario (52 percent to 63 percent versus 40 percent) (Table 6). For the other months, this percentage was similar (greater than 15 percent).

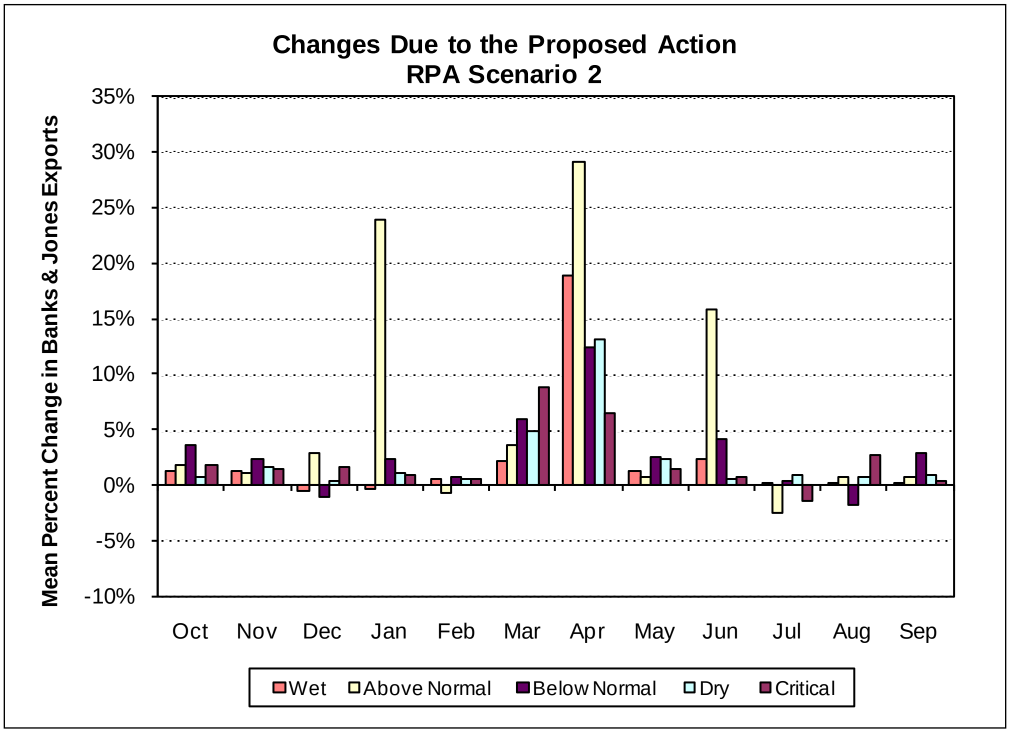




Key:
RPA = reasonable and prudent alternative

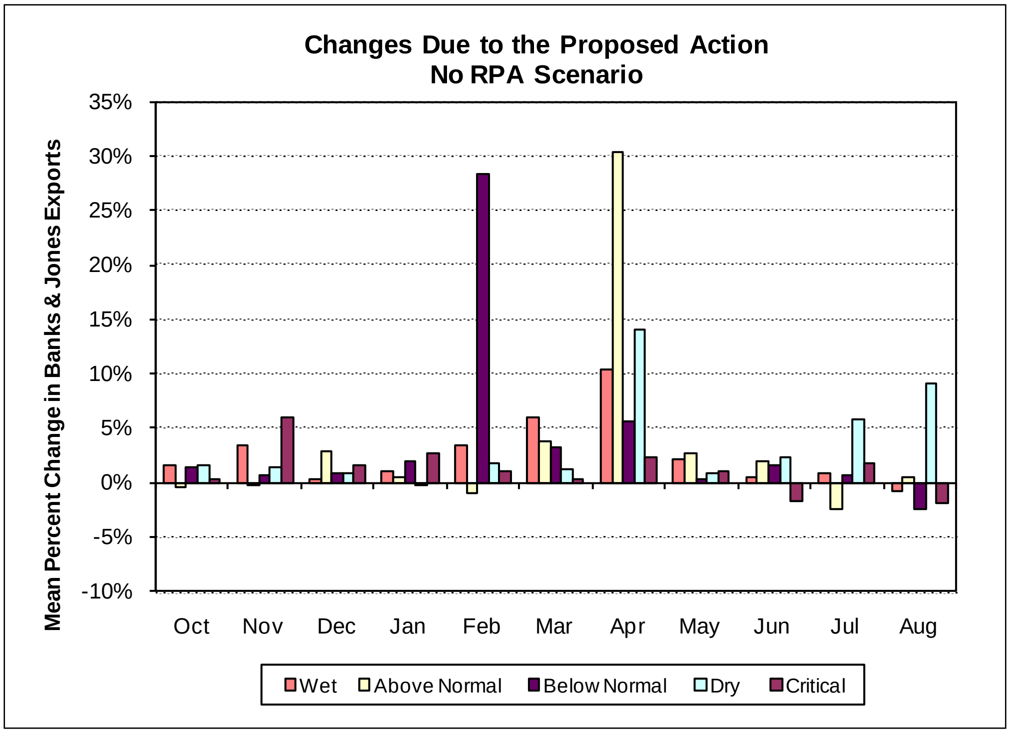
Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities

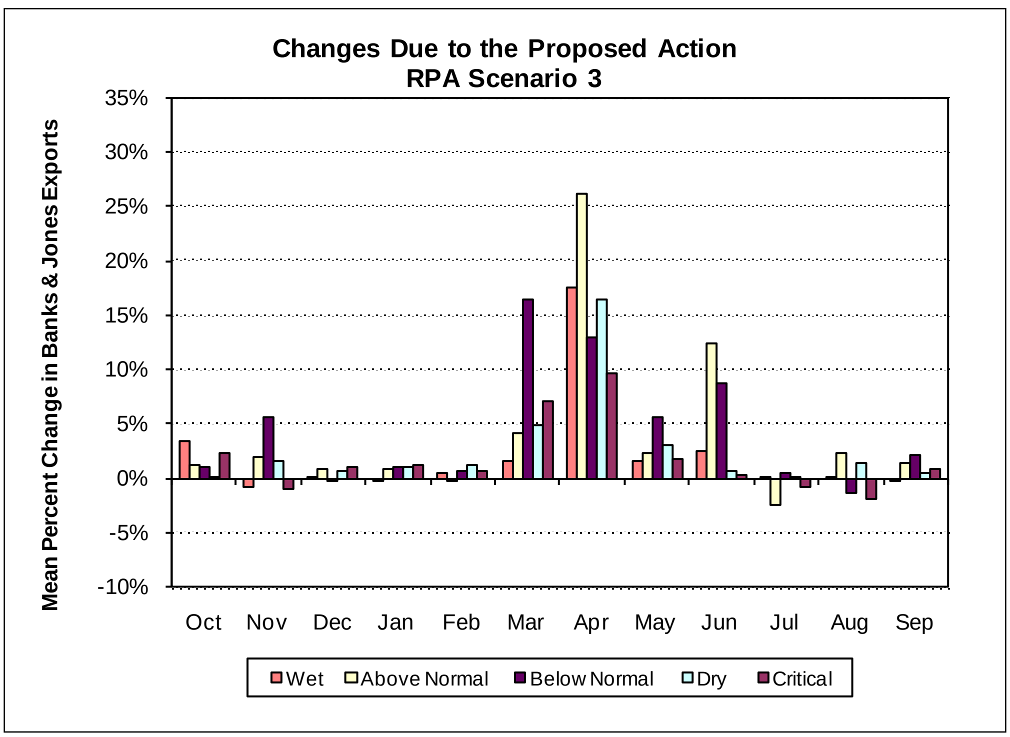




Key:
RPA = reasonable and prudent alternative

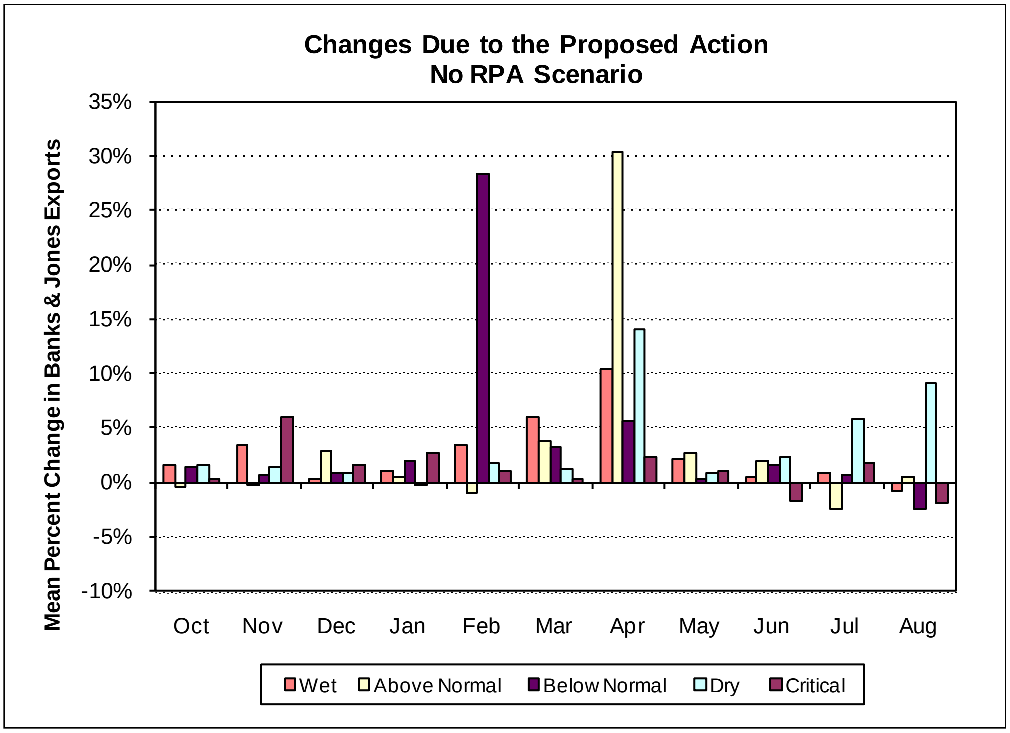
Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities (contd.)

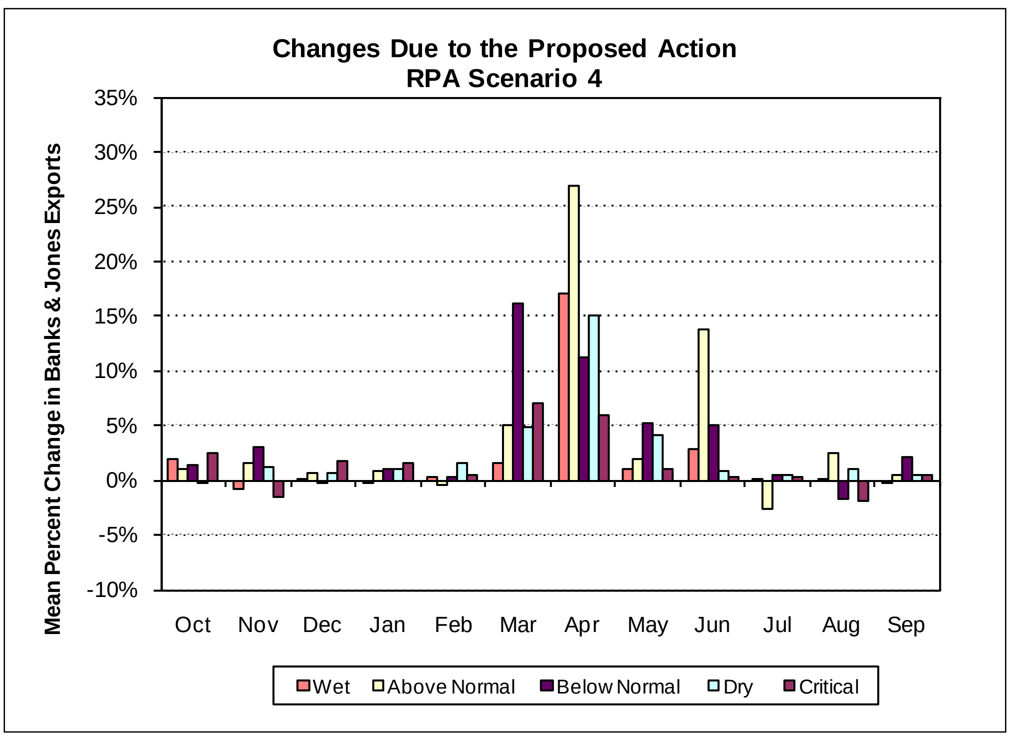




Key:
RPA = reasonable and prudent alternative

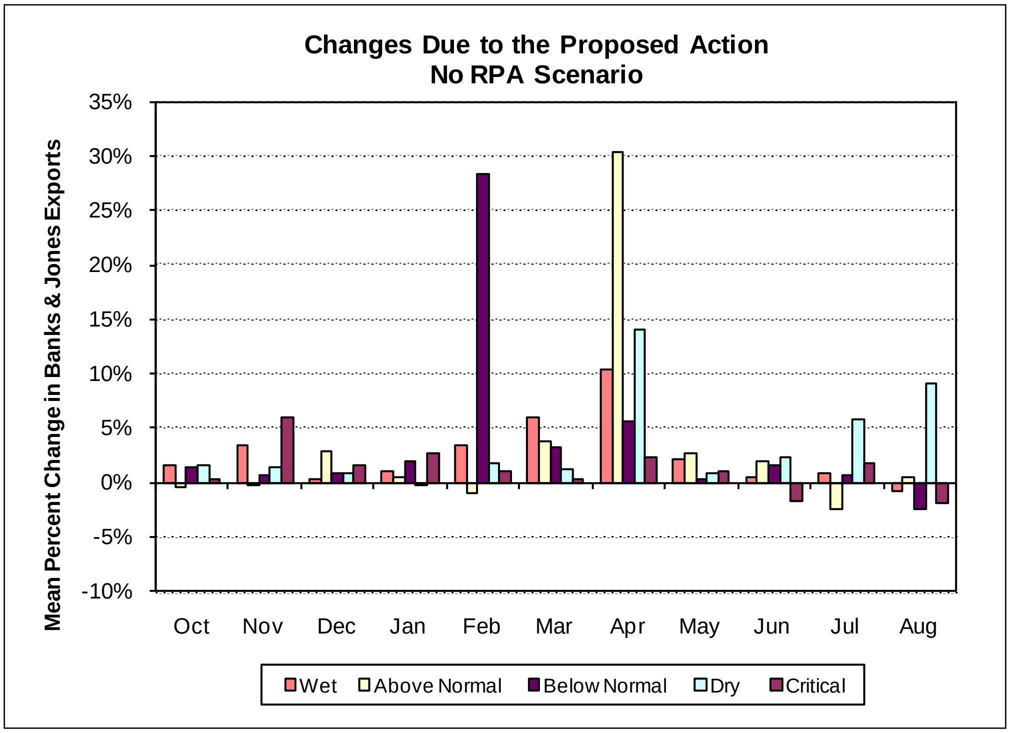
Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities (contd.)

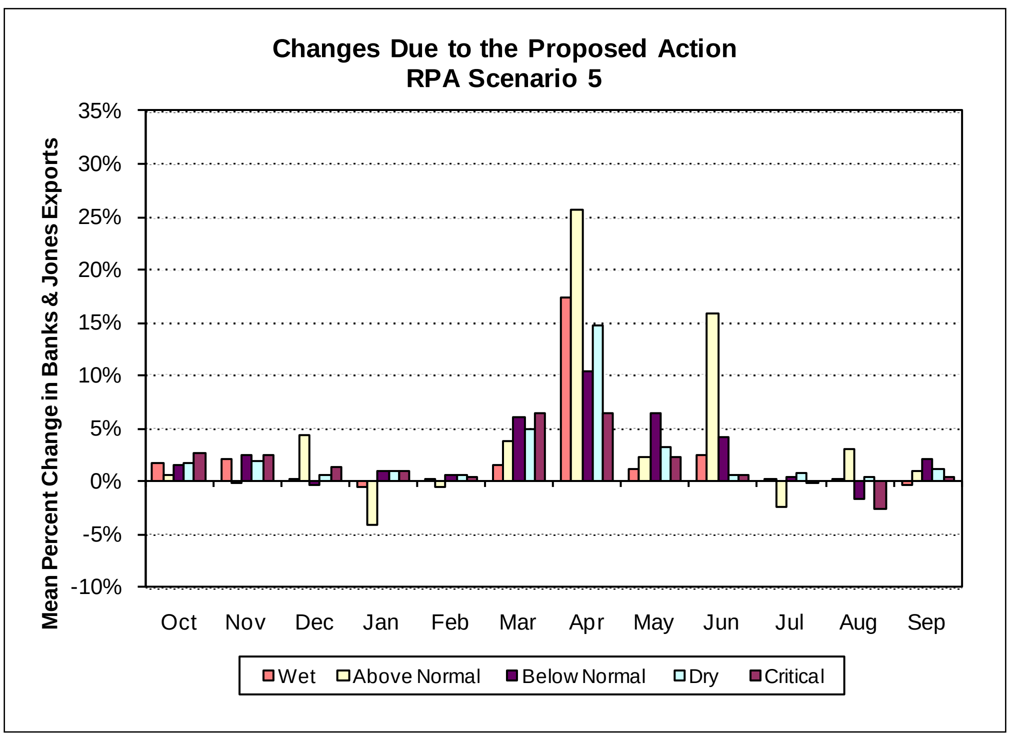




Key:
RPA = reasonable and prudent alternative

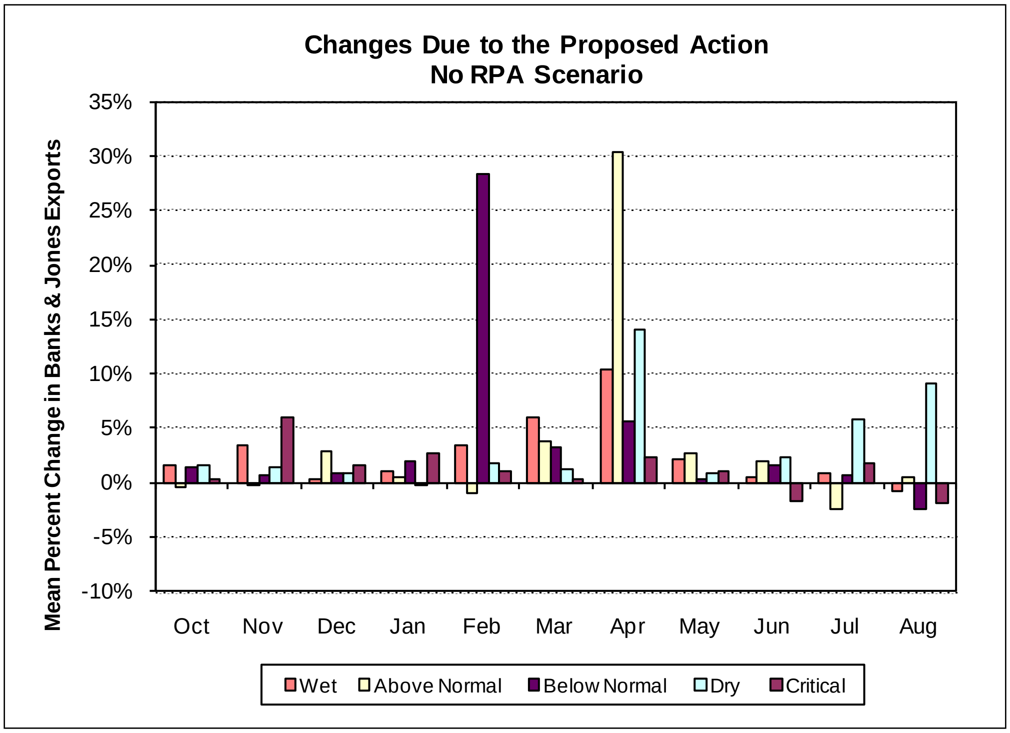
Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities (contd.)

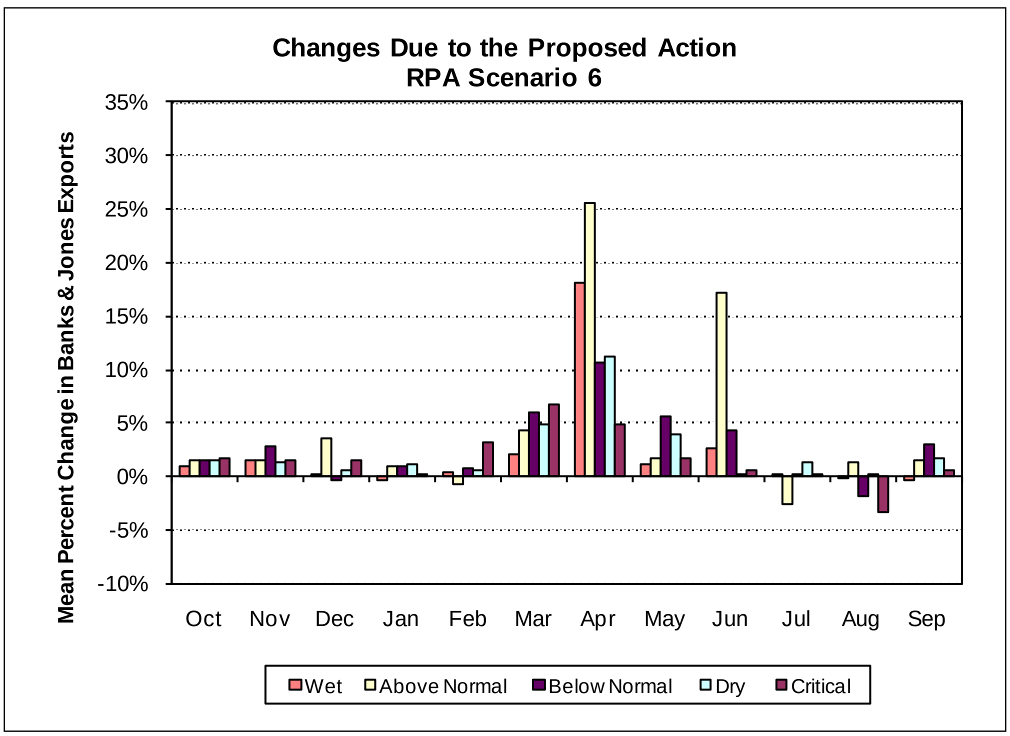




Key:
RPA = reasonable and prudent alternative

Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities (contd.)





Key:
RPA = reasonable and prudent alternative

Figure 3.
Mean Percent Changes in Diversions at the Jones and Banks Facilities (contd.)

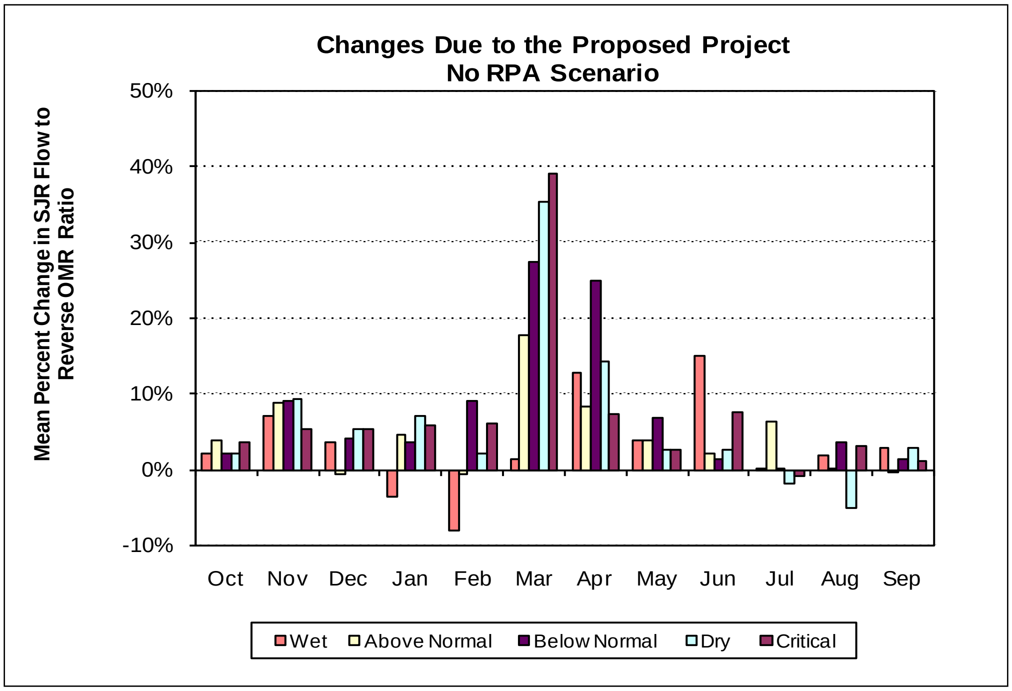
Table 6.
Percentage of Years for Which Diversions Increased by More Than 10 Percent

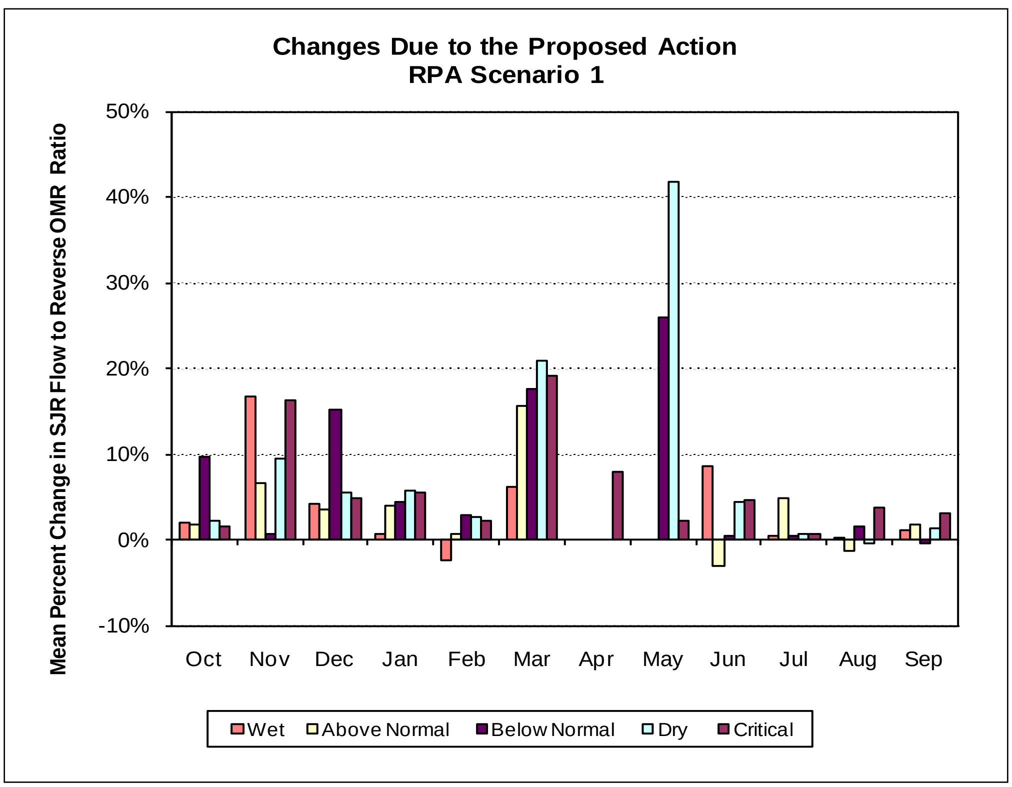
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	6	4	5	7	9	23	40	5	4	6	4	4
RPA 1	4	9	1	1	0	10	63	5	7	1	4	6
RPA 2	4	9	2	2	2	9	63	6	7	1	4	6
RPA 3	6	6	2	1	0	7	62	11	9	1	2	7
RPA 4	5	4	1	1	1	10	54	11	9	1	4	5
RPA 5	5	5	2	0	1	6	57	12	9	2	2	5
RPA 6	1	4	2	0	1	10	52	12	10	1	1	6

4.2.4 Ratio of San Joaquin River Flow at Vernalis to OMR Flows

The results for the ratio of San Joaquin River flow to OMR flow were similar to those for OMR flow because the OMR flow changed substantially in the RPA scenarios compared to the No RPA scenario, whereas the results for San Joaquin River flow were largely the same. Differences in the ratio in the No RPA scenario and the RPA scenario results were greatest for April and May (Figure 4). No results are given in RPA scenarios 1 and 3 through 6 in April of Wet, AN, BN, and Dry years and RPA scenarios 2 of Wet, BN, and AN years because OMR flows were positive, or the ratios were greater than 5, so these years were excluded from computations of mean values. Positive OMR flows and ratios greater than 5 indicate favorable conditions for the fish. Similarly, no results are given in RPA scenarios 1, 2, 3, 5, and 6 in May of Wet and AN years and RPA scenario 4 of Wet, AN, and BN years. In March of BN, Dry, and Critical years, the ratio increased more in the No RPA scenario than in the RPA scenarios. Note that the differences in the March are because of small but consistent differences between the No RPA and the RPA scenarios in results for OMR flows (Figure 4).

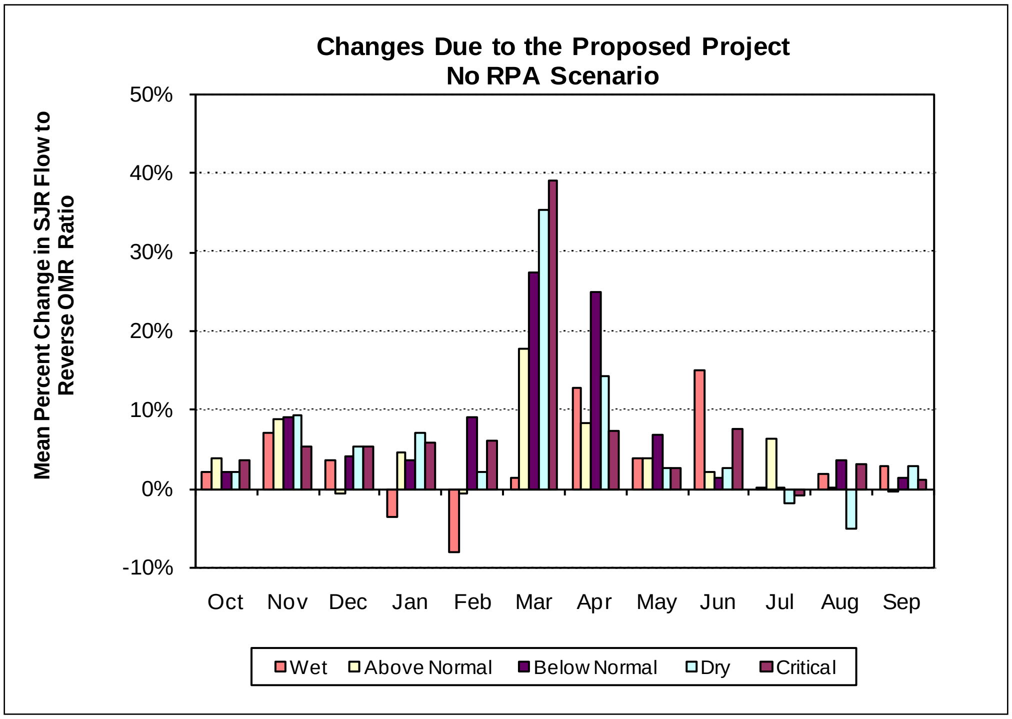
The percentage of years in which the ratios of San Joaquin River flow to OMR flow decreased by more than 10 percent was higher for the No RPA scenario than in the RPA scenarios in every month of the critical February-to-June period, except April of RPA scenarios 3 and 4 and June of all six RPA scenarios (Table 7). For the other months, the percentage for the No RPA scenario was higher than or similar to the percentages for the RPA scenarios, except September, which consistently had higher percentages for the RPA scenarios.

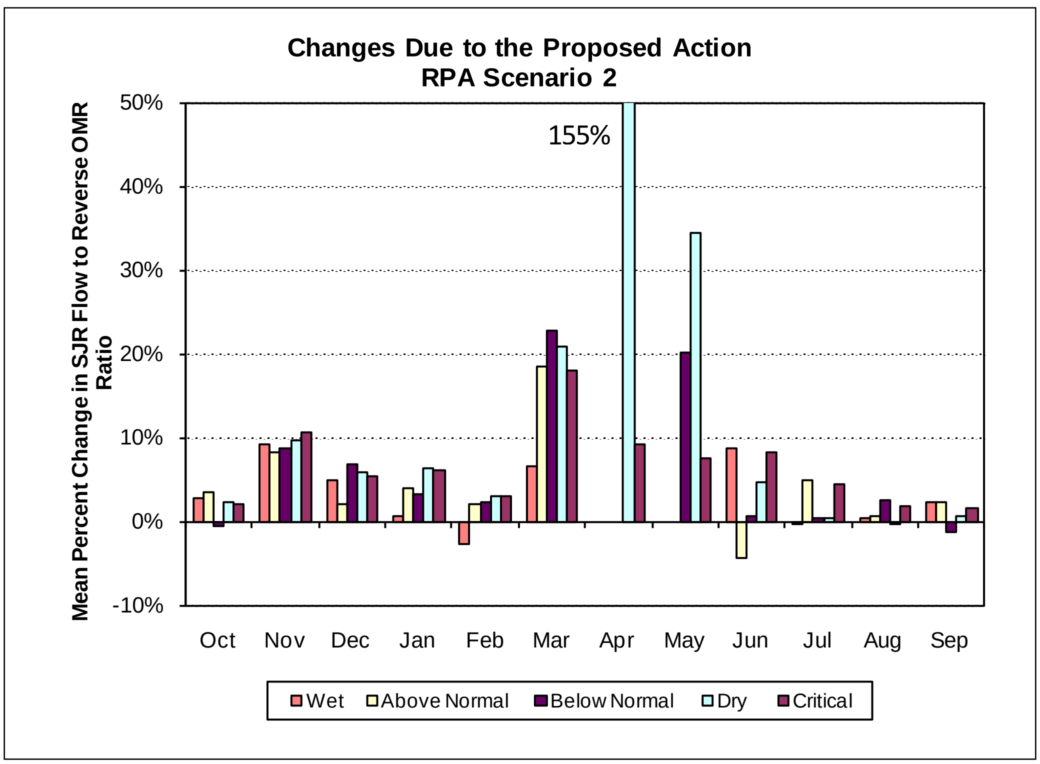




Note: Reverse OMR flows given positive sign to give ratios positive values
Key:
RPA = reasonable and prudent alternative

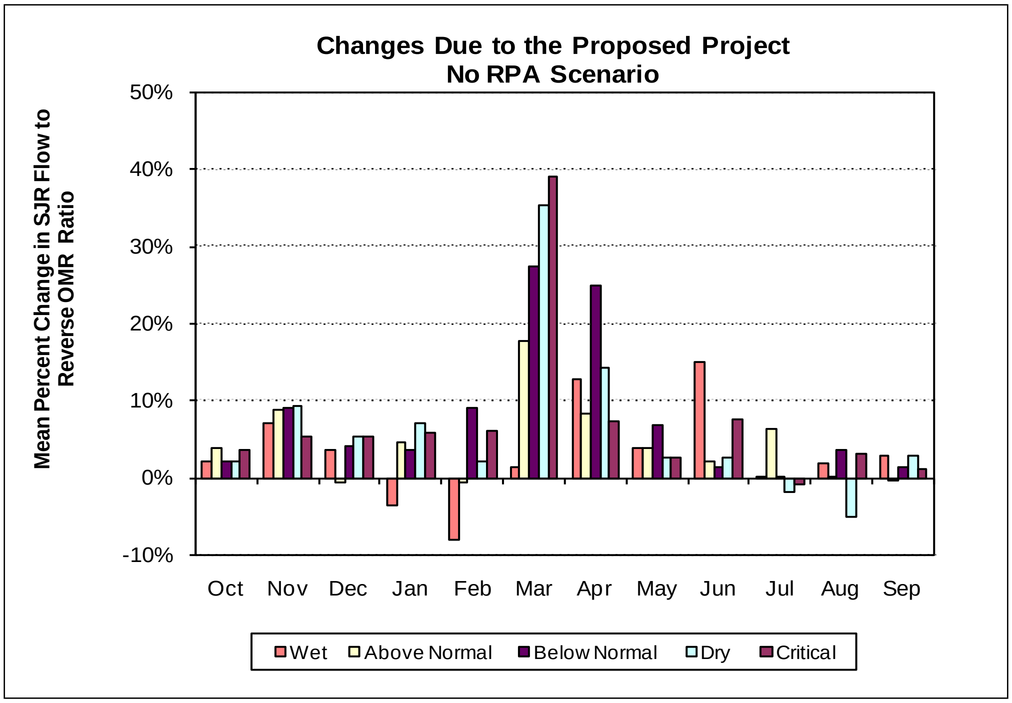
Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined

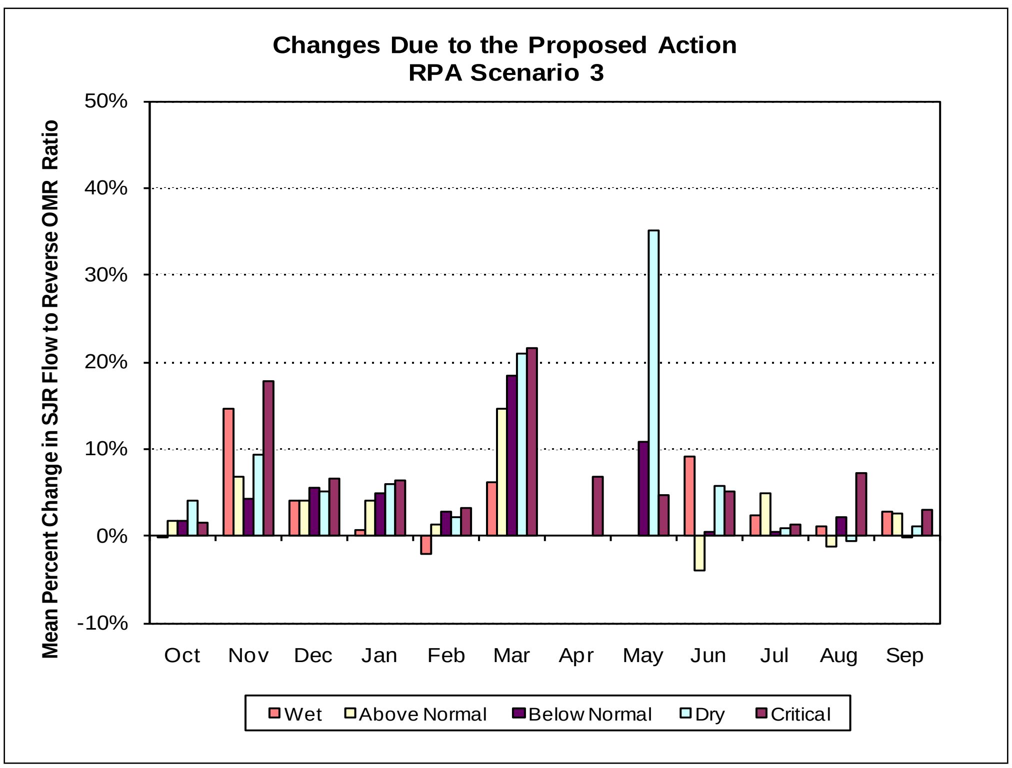




Note: Reverse OMR flows given positive sign to give ratios positive values
Key:
RPA = reasonable and prudent alternative

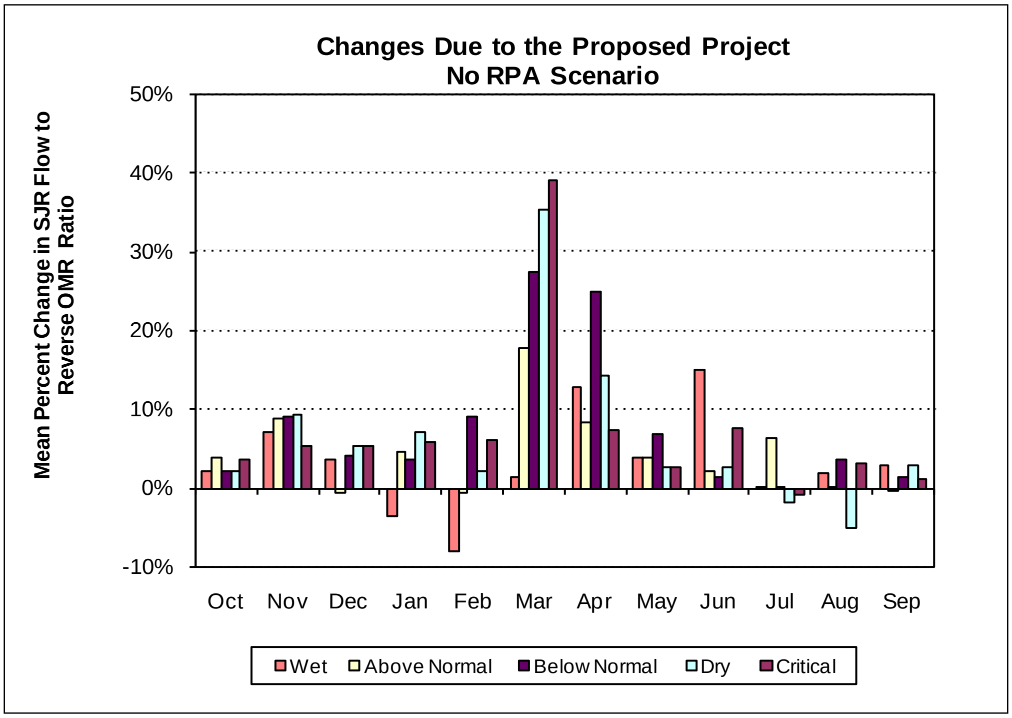
Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined (contd.)

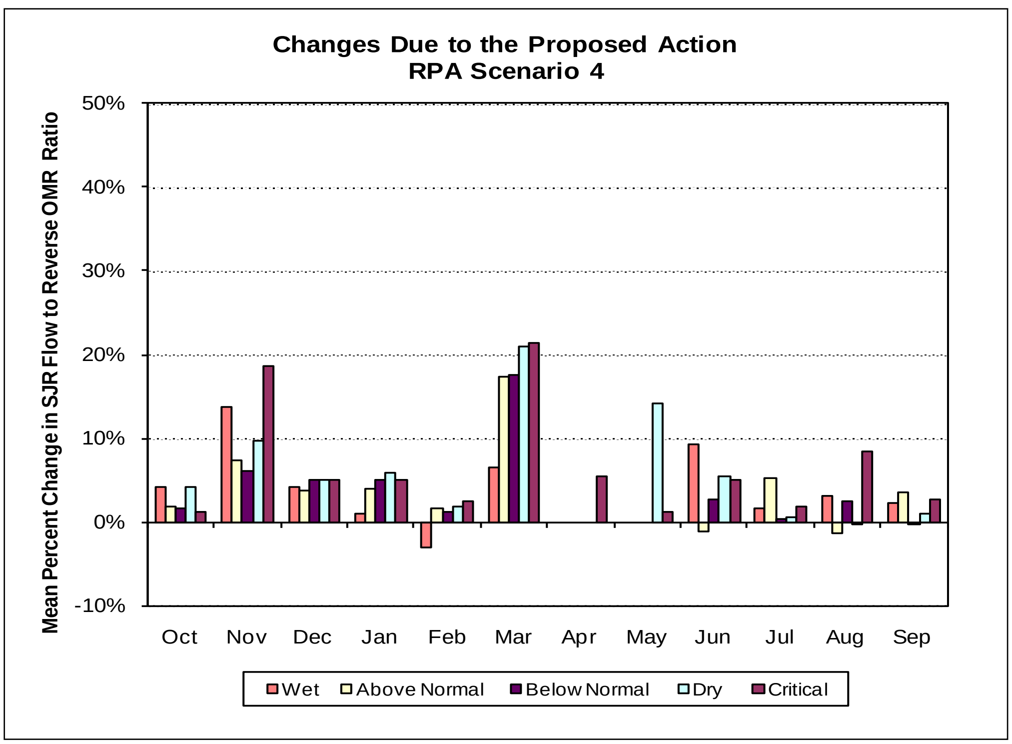




Note: Reverse OMR flows given positive sign to give ratios positive values
Key:
RPA = reasonable and prudent alternative

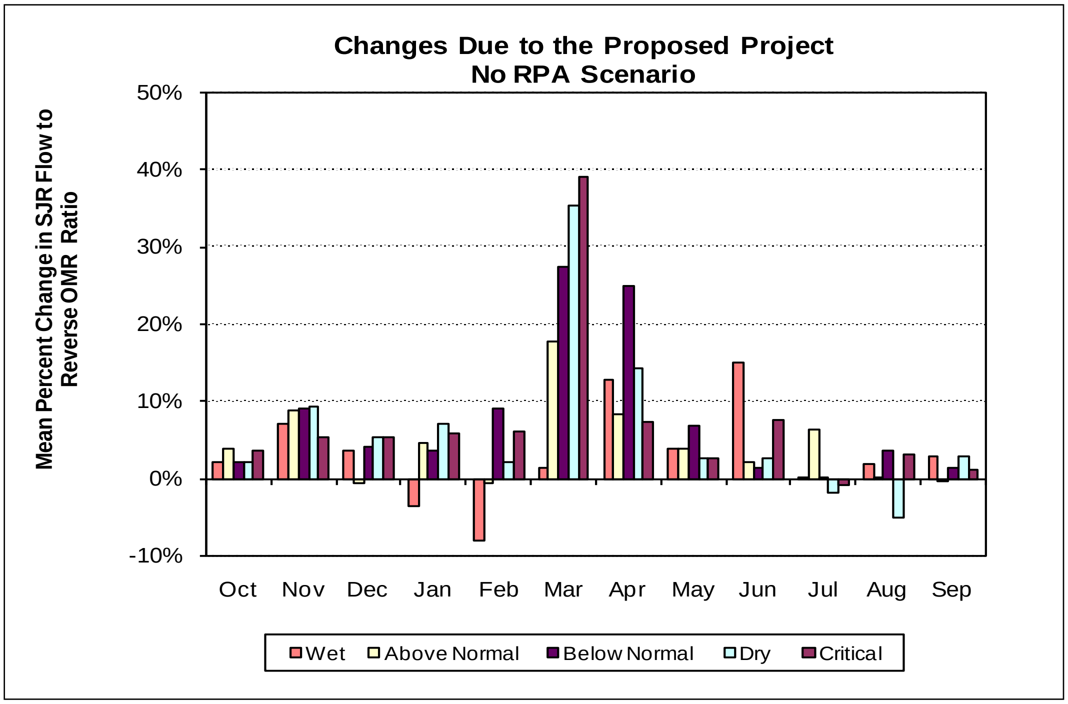
Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined (contd.)

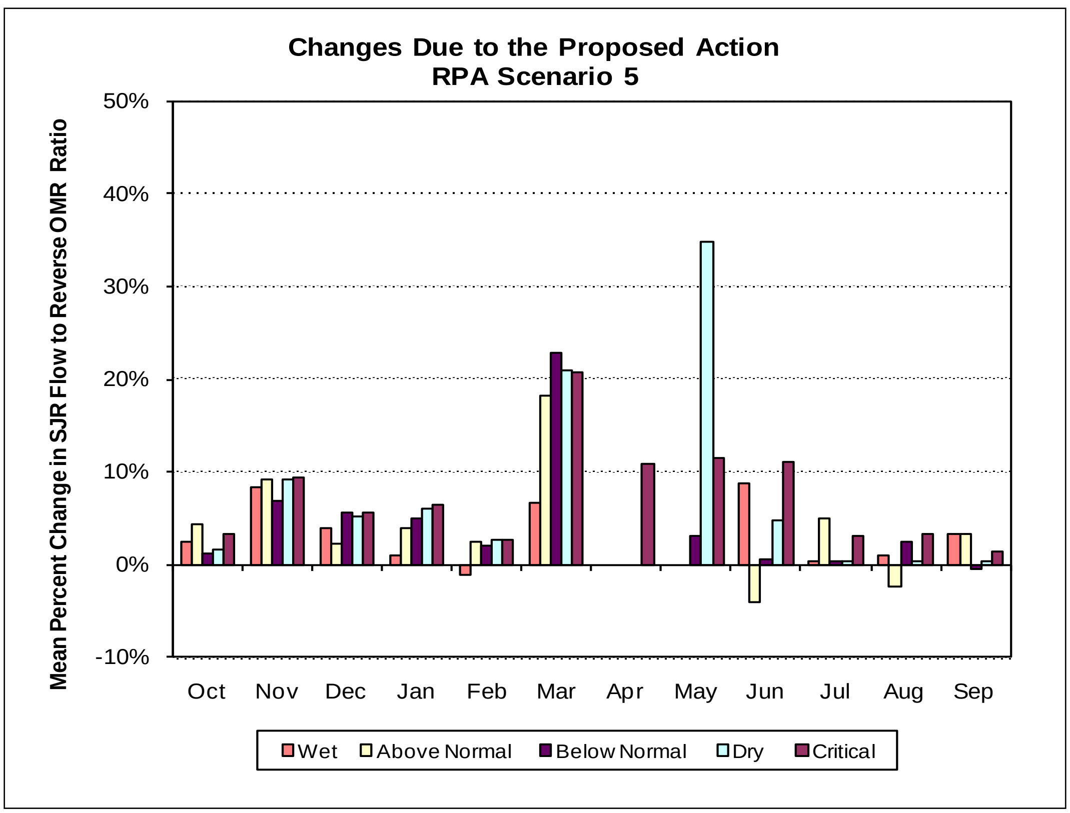




Note: Reverse OMR flows given positive sign to give ratios positive values
Key:
RPA = reasonable and prudent alternative

Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined (contd.)



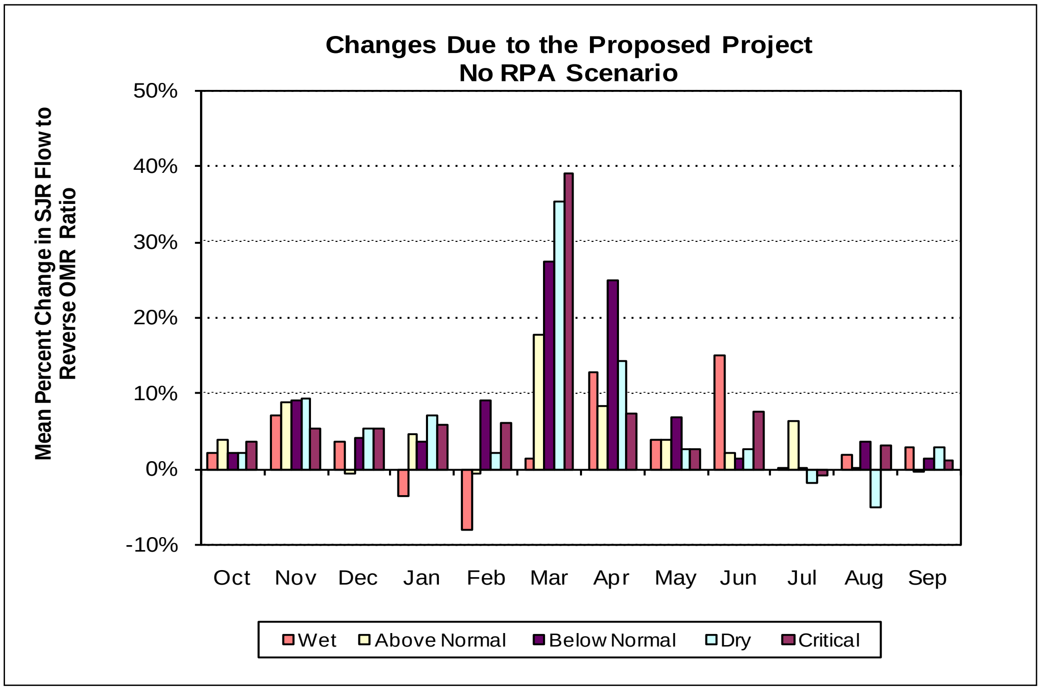


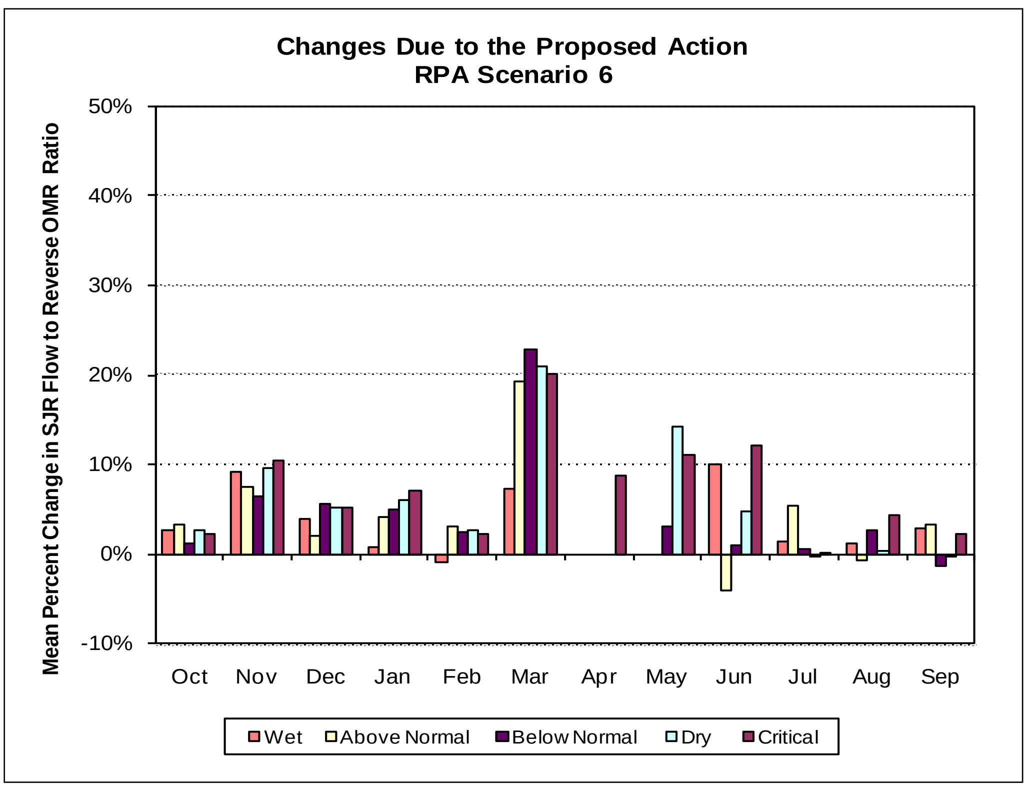
Note: Reverse OMR flows given positive sign to give ratios positive values

Key:

RPA = reasonable and prudent alternative

Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined (contd.)





Note: Reverse OMR flows given positive sign to give ratios positive values
Key:
RPA = reasonable and prudent alternative

Figure 4.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Reverse Flow of Old and Middle Rivers Combined (contd.)

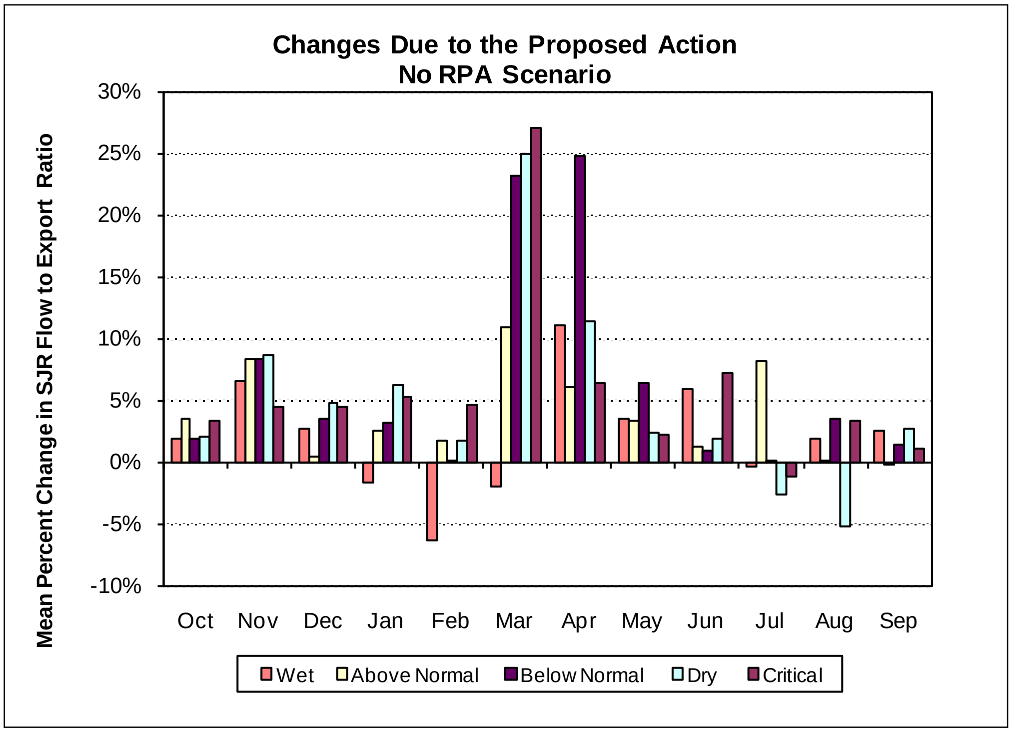
Table 7.
The Percentage of Years for Which the Ratio of San Joaquin River Flow to Reverse Flow of Old and Middle Rivers Combined Decreased by More Than 10 Percent

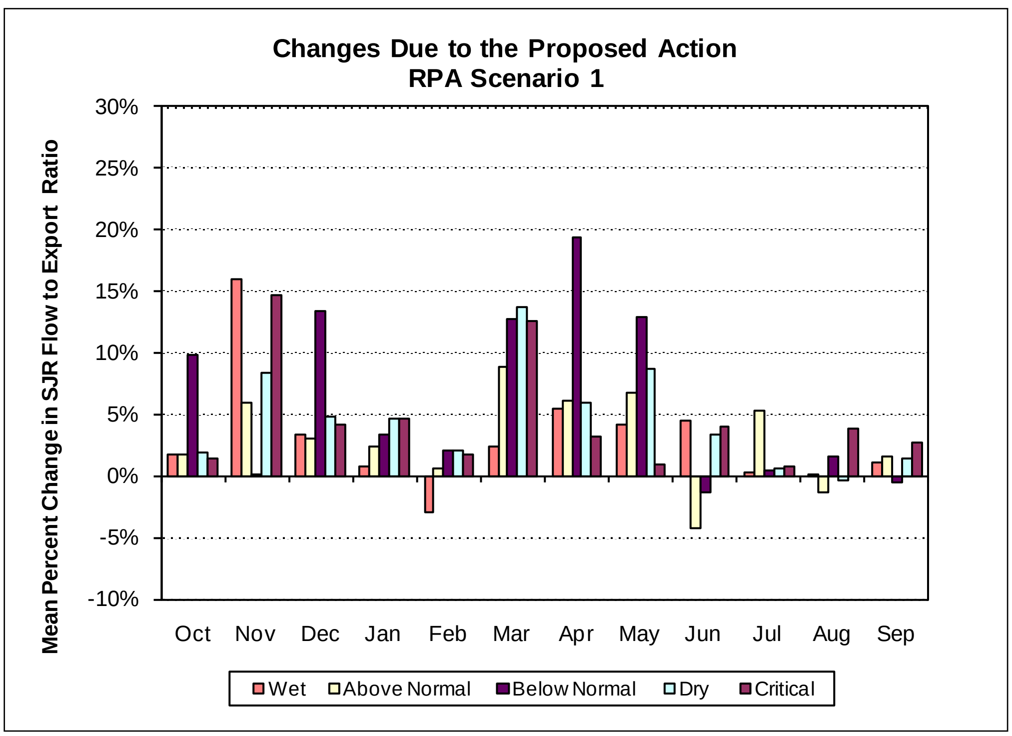
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	4	5	3	7	12	4	1	2	4	6	2	0
RPA 1	2	2	0	1	6	4	0	0	5	1	4	5
RPA 2	2	2	3	3	7	3	0	0	6	0	2	6
RPA 3	4	1	0	3	10	1	7	0	6	0	2	6
RPA 4	2	0	0	1	8	1	7	0	6	0	2	5
RPA 5	1	1	3	1	8	0	0	0	6	0	1	4
RPA 6	0	0	3	1	10	0	0	0	6	1	0	5

4.2.5 Ratio of San Joaquin River at Vernalis to Jones and Banks Diversions

The results for the ratio of San Joaquin River flow to Jones and Banks diversions were similar to the results for the ratio for San Joaquin River flow to OMR flow. This is because the results for Jones and Banks diversions included substantial changes between the No RPA implementation and the RPA scenarios, whereas the results for San Joaquin River flow had little change. The difference in ratio of San Joaquin River flow to diversions in June of AN and BN years was higher in the No RPA scenario than in the RPA scenarios (Figure 5). Similarly, for March, except in Wet years, the difference in the ratio was higher in the No RPA scenario than in the RPA scenarios. For April, increases in the ratios were consistently greater in the No RPA scenario than in the RPA scenarios in all year types, except for AN years in RPA scenarios 1 and 2. In contrast, for May, increases in the ratios were consistently greater in the RPA scenarios than in the No RPA scenario, except for Critical years in RPA scenarios 1 and 4.

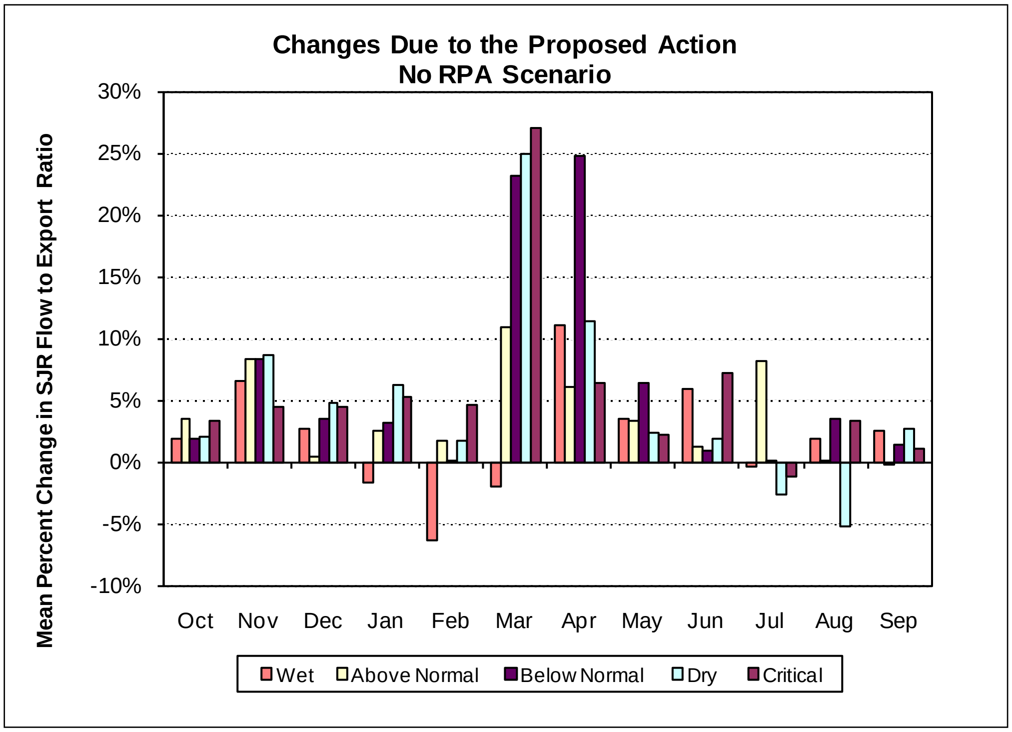
The percentage of years for which the ratio of San Joaquin River flow to Jones and Banks diversions increased by more than 10 percent was higher in January and February in the No RPA scenario than in the RPA scenarios (Table 8). The percentage was less than 10 percent for all months and scenarios, except February in the No RPA scenario, where it was 16 percent.

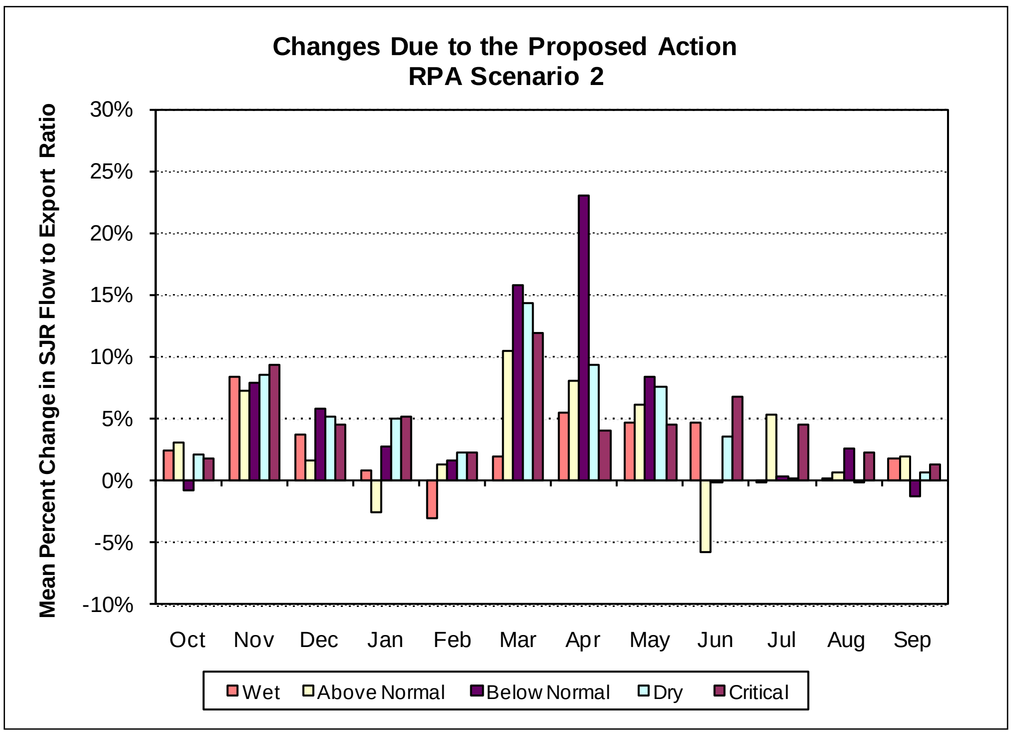




Key:
RPA = reasonable and prudent alternative

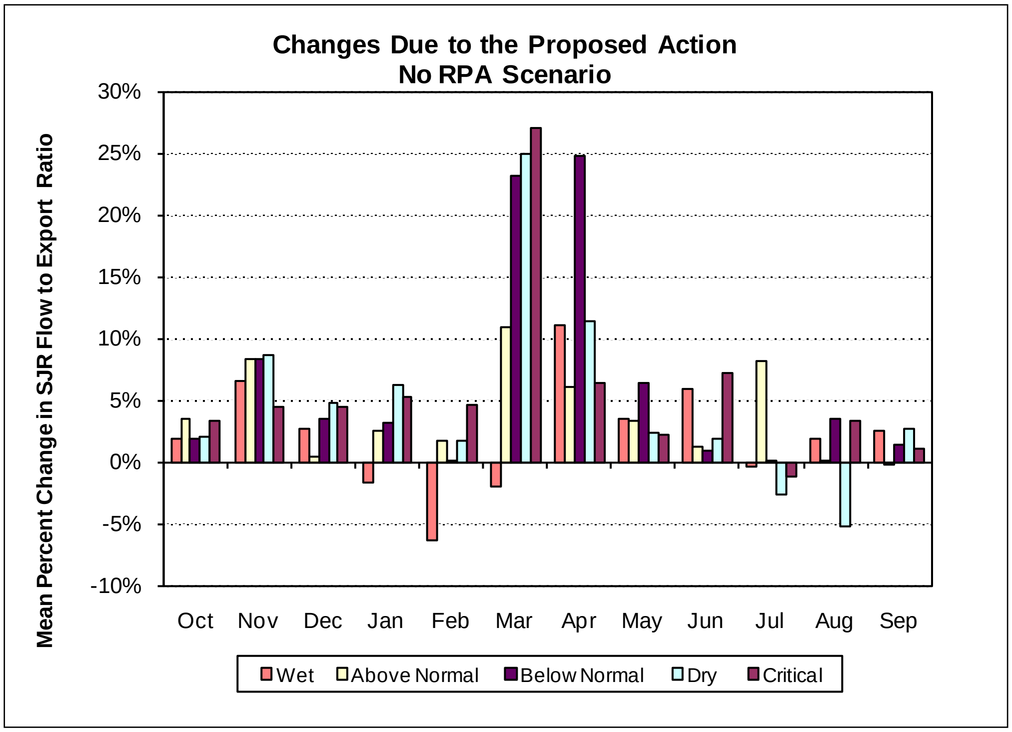
Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities

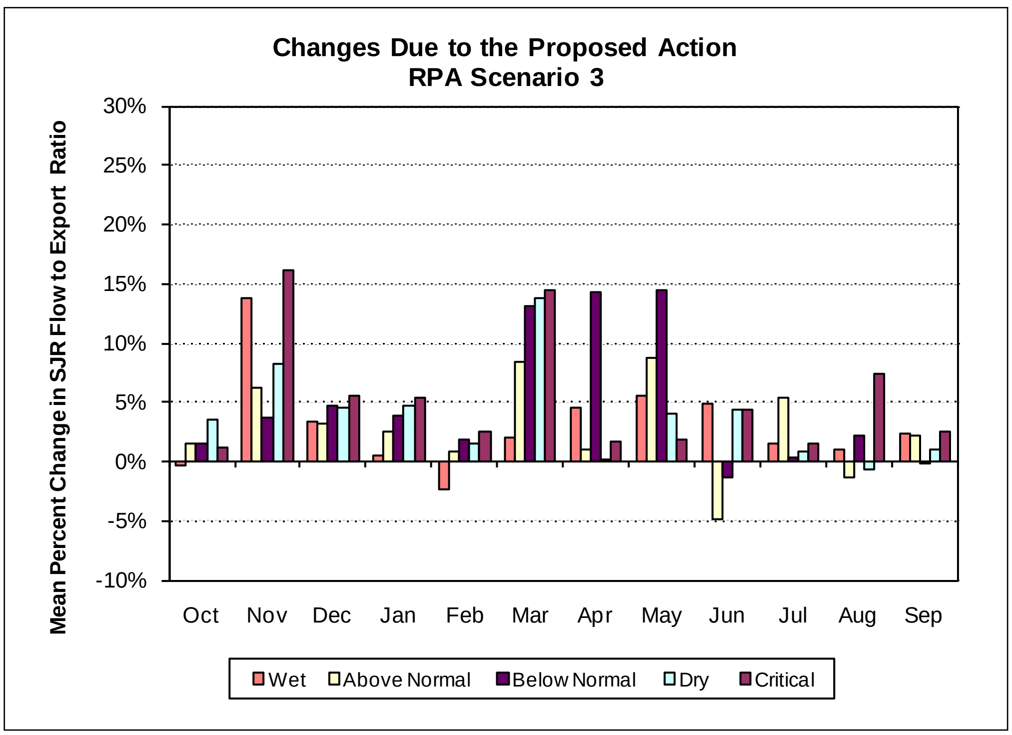




Key:
RPA = reasonable and prudent alternative

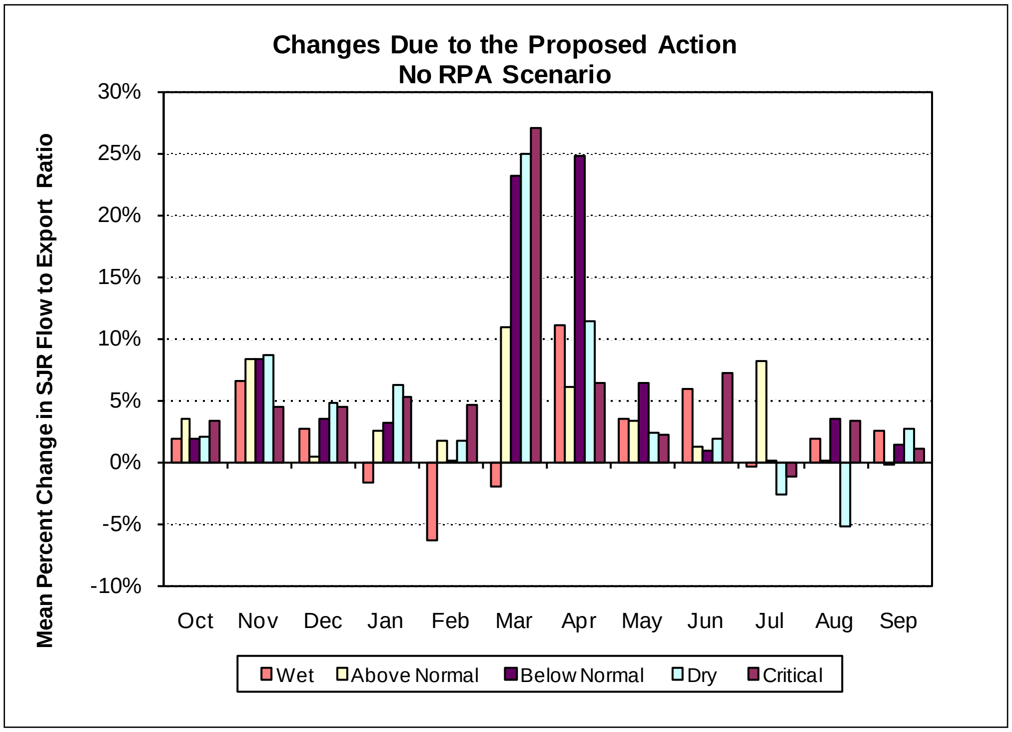
Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities (contd.)

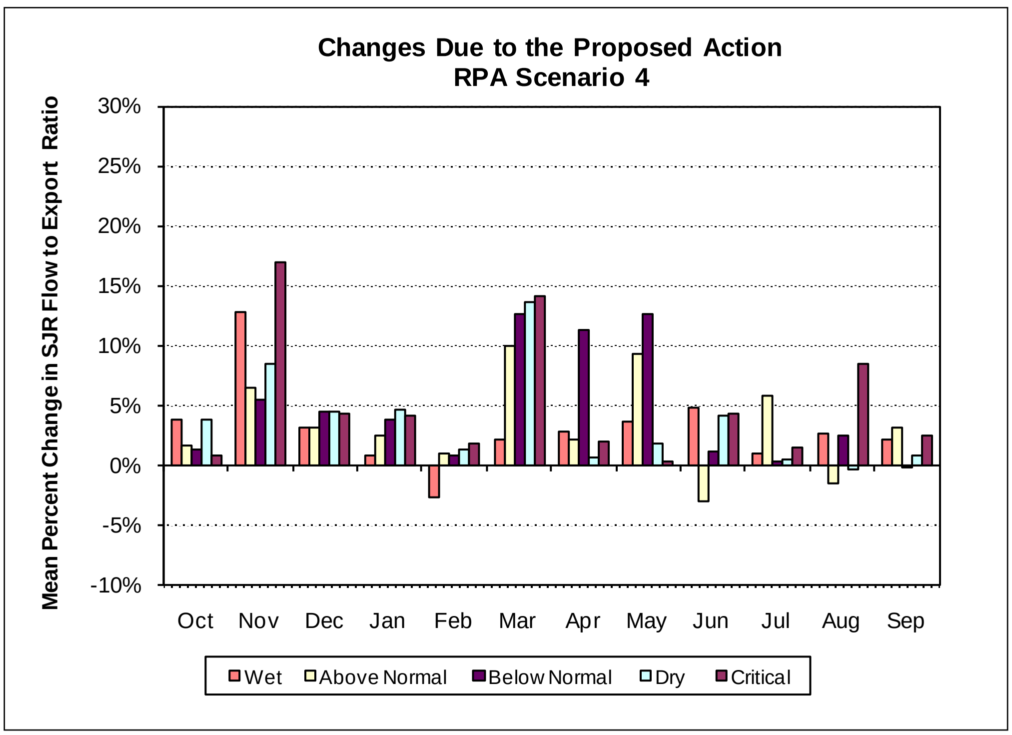




Key:
RPA = reasonable and prudent alternative

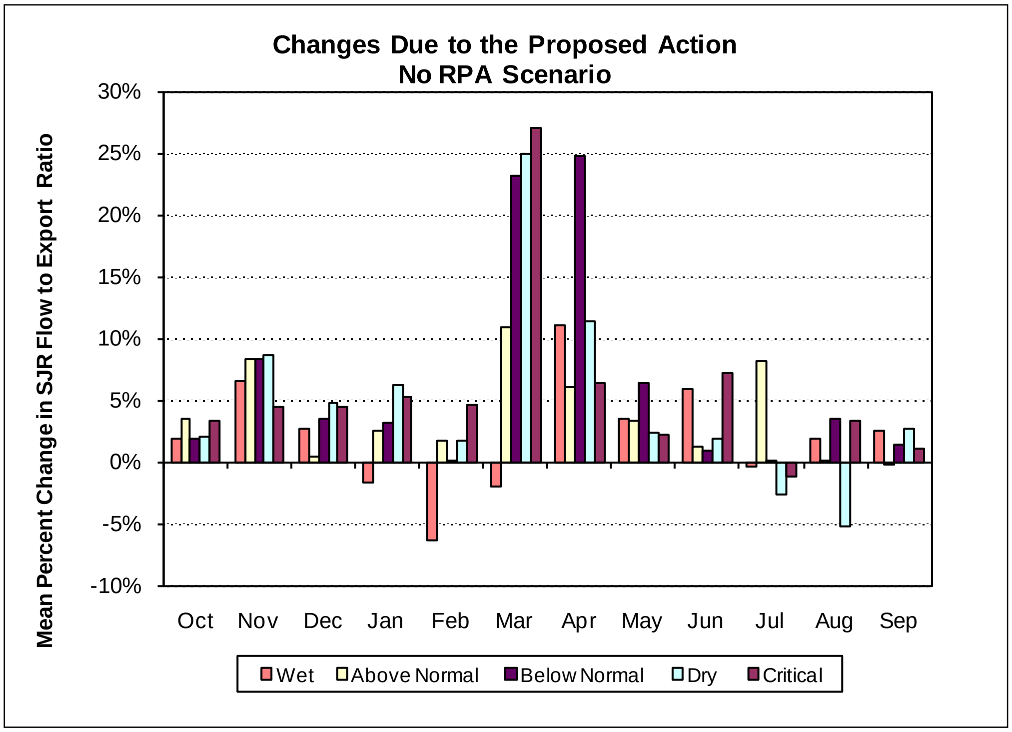
Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities (contd.)

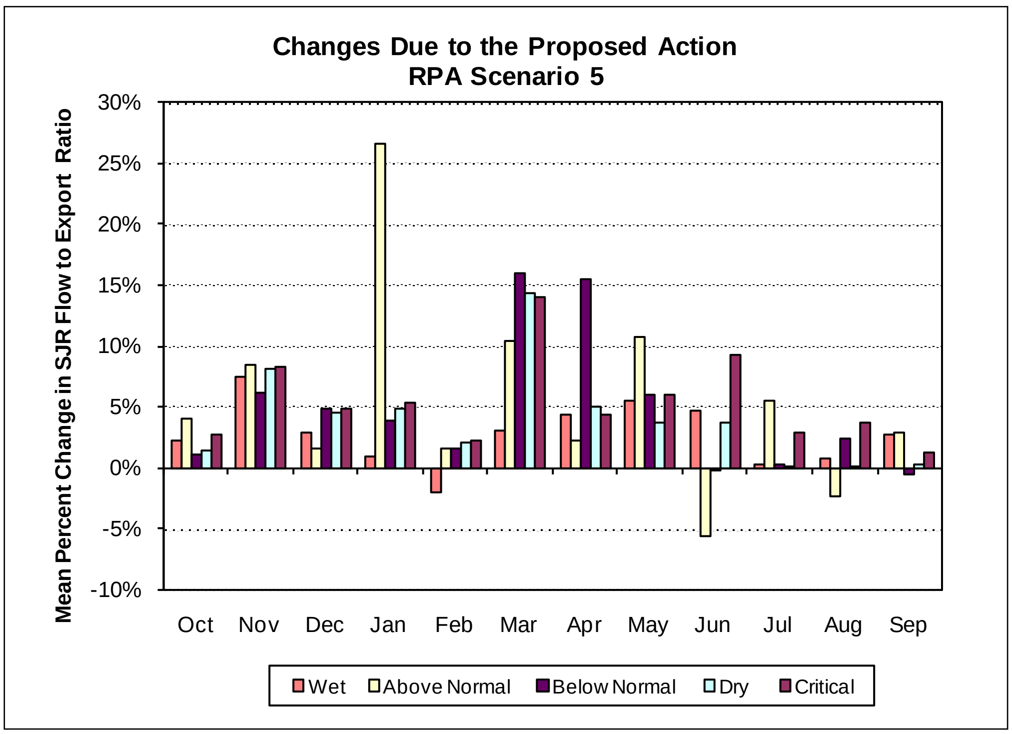




Key:
RPA = reasonable and prudent alternative

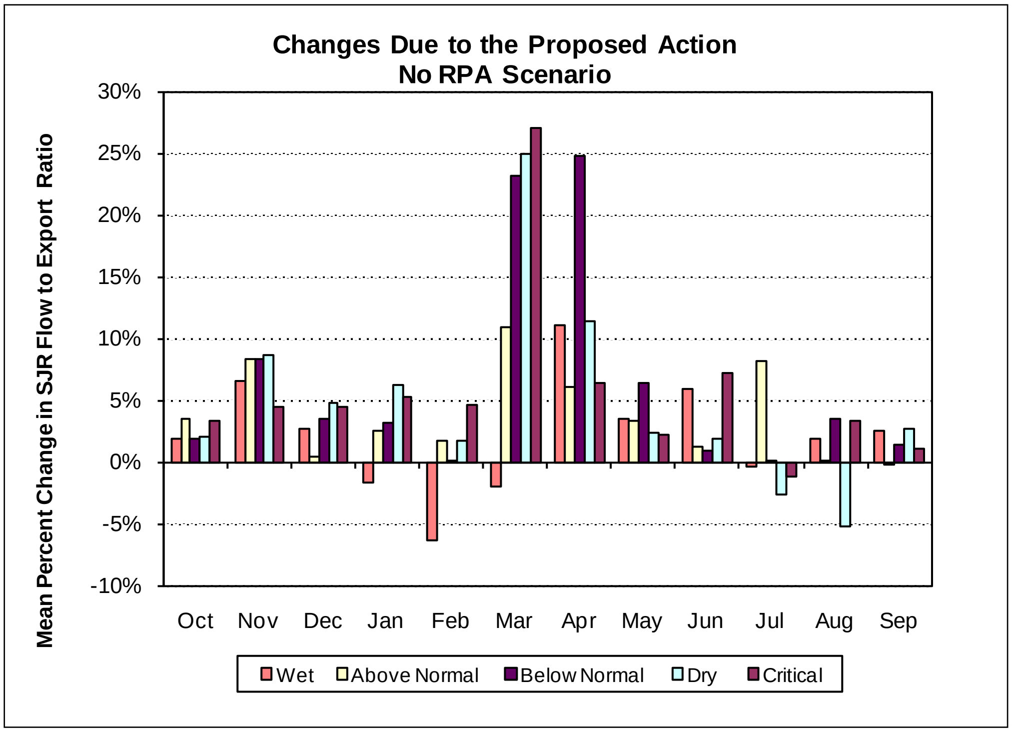
Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities (contd.)

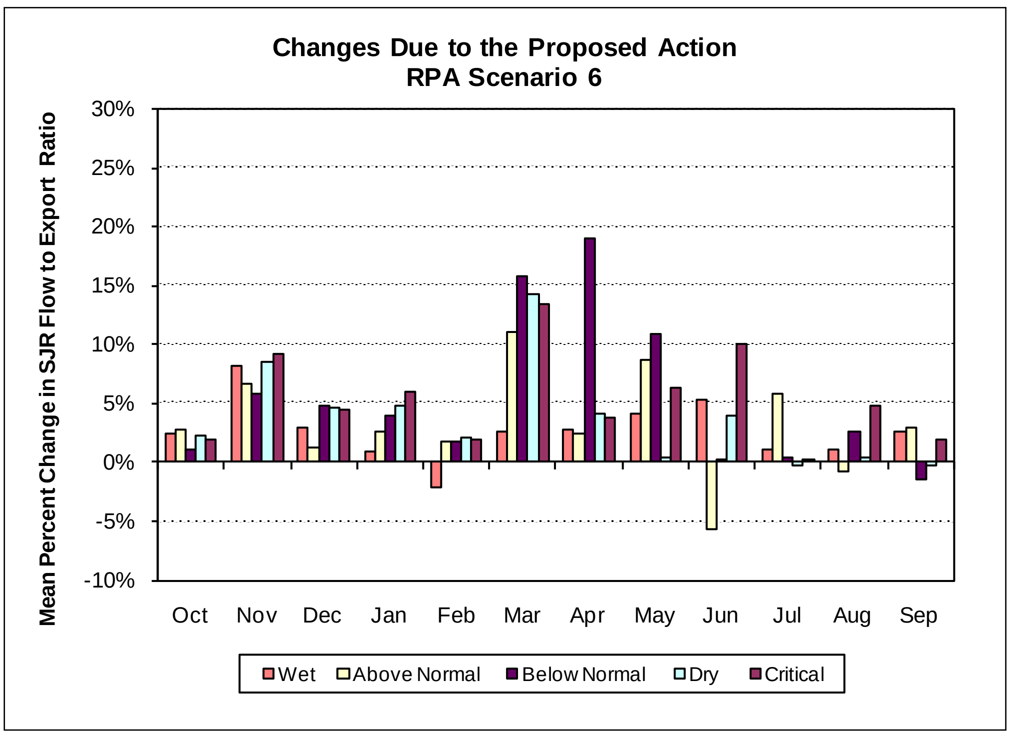




Key:
RPA = reasonable and prudent alternative

Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities (contd.)





Key:
RPA = reasonable and prudent alternative

Figure 5.
Mean Percent Changes in Ratio of San Joaquin River at Vernalis Flow to Diversions at Jones and Banks Facilities (contd.)

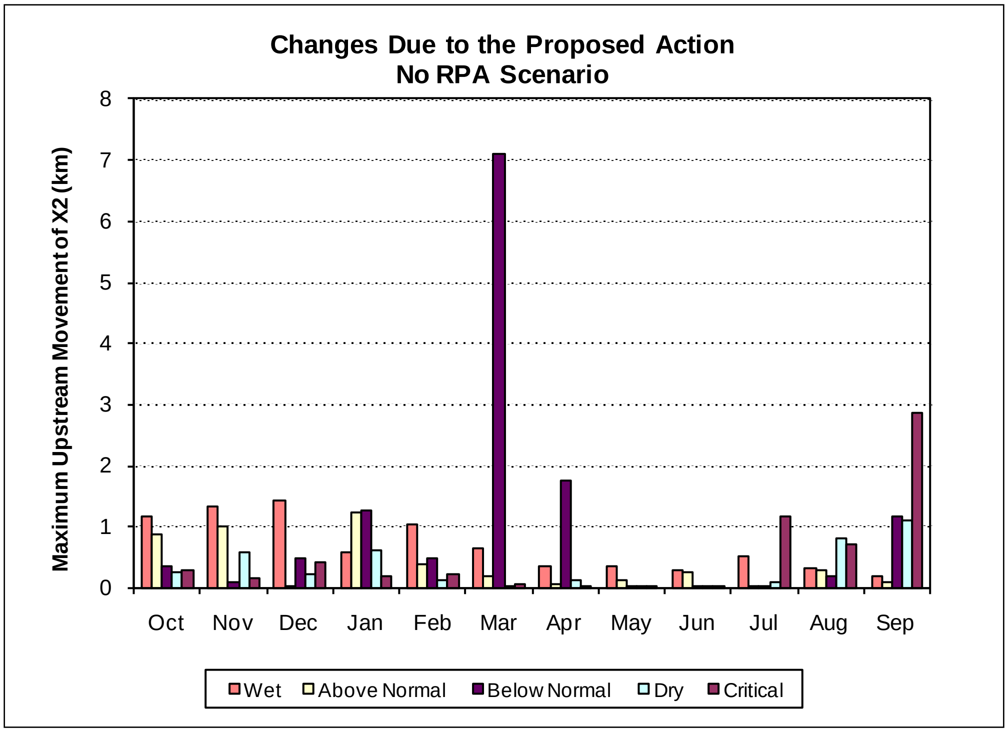
Table 8.
The percentage of years for which the ratio of San Joaquin River flow to Jones and Banks diversions increased by more than 10 percent

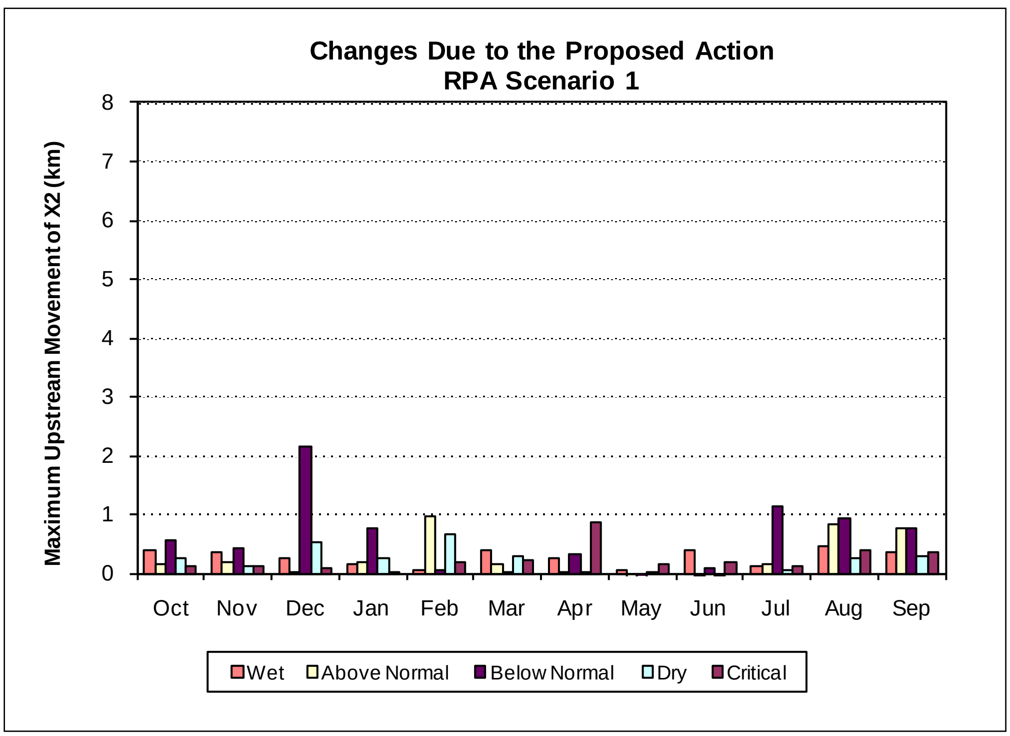
	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	4	4	2	6	16	2	4	2	4	6	2	0
RPA 1	2	2	0	0	5	2	0	0	6	1	4	6
RPA 2	2	2	1	2	5	2	0	0	6	0	2	6
RPA 3	4	1	0	0	4	1	2	0	6	0	2	6
RPA 4	2	0	0	0	2	1	2	0	5	0	2	5
RPA 5	1	1	1	0	2	0	0	0	6	0	1	4
RPA 6	0	0	1	0	2	0	0	0	6	1	1	5

4.2.6 X2

In general, the change in average maximum upstream shift of X2 was slightly greater in the No RPA scenario than in the RPA scenarios. Most of the averages were less than 1 kilometer (Figure 6), which is unlikely to have a significant effect on fish. Exceptions include shifts of several kilometers in January and February of AN years in RPA scenarios 2, 5 and 6. The corresponding shift in the No RPA scenario is smaller. In March of Dry years, the change in the shift of X2 in the No RPA scenario was more than 4 kilometers, whereas the corresponding change in shift of X2 was consistently smaller in the RPA scenarios. The movements were very small for all months and year types for RPA scenario 3, and even more so in the RPA scenario 4.

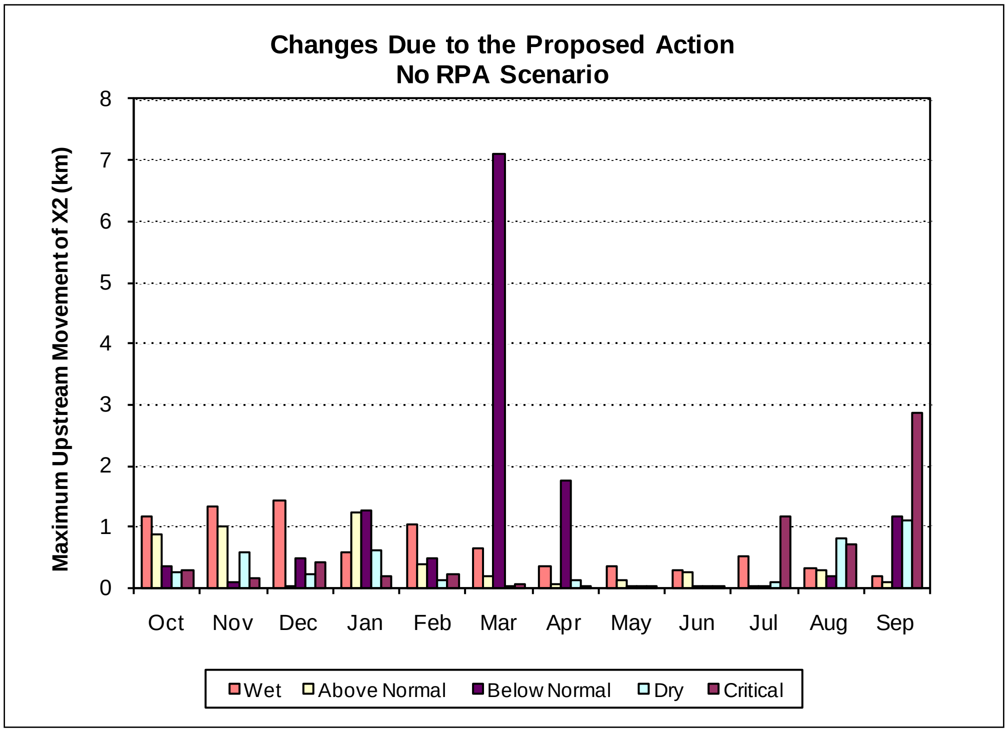
The percentage of years with upstream shifts of more than 1 kilometer was less than 4 percent for all months in both the No RPA scenario and the RPA scenarios (Table 9).

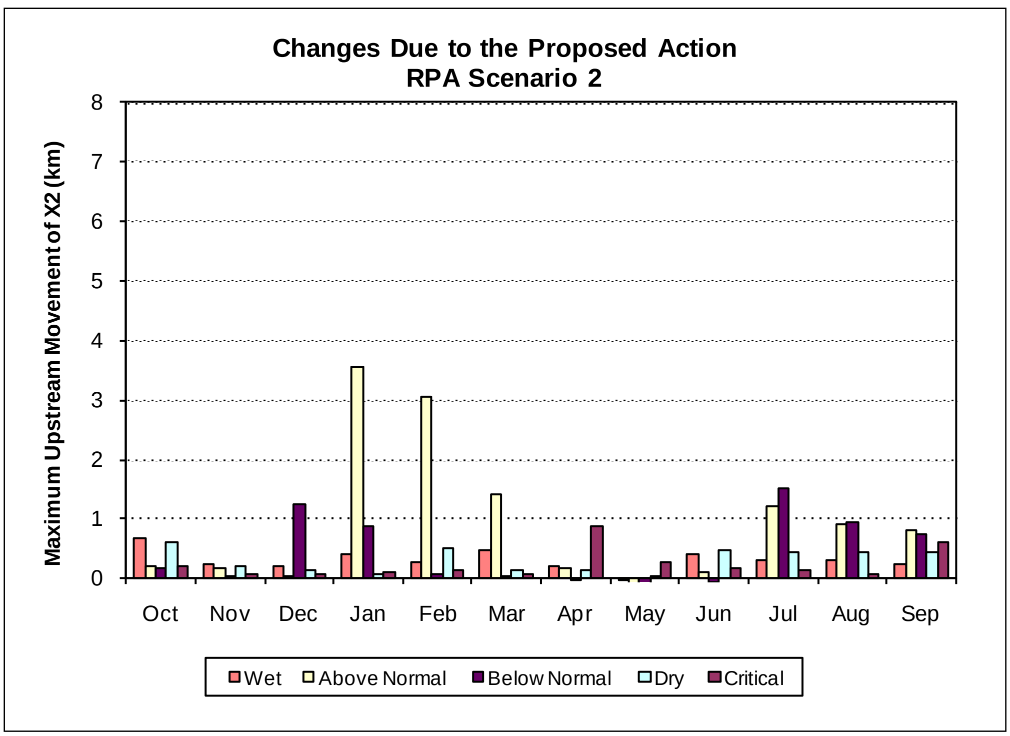




Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

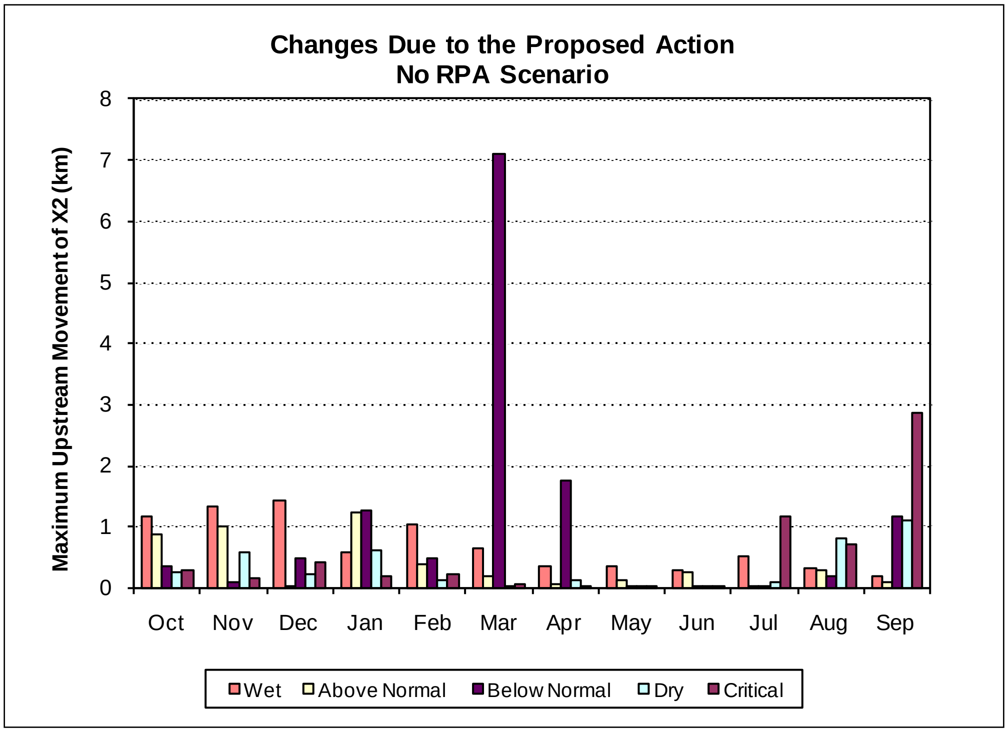
Figure 6.
Maximum Mean Monthly Upstream Shifts in X2

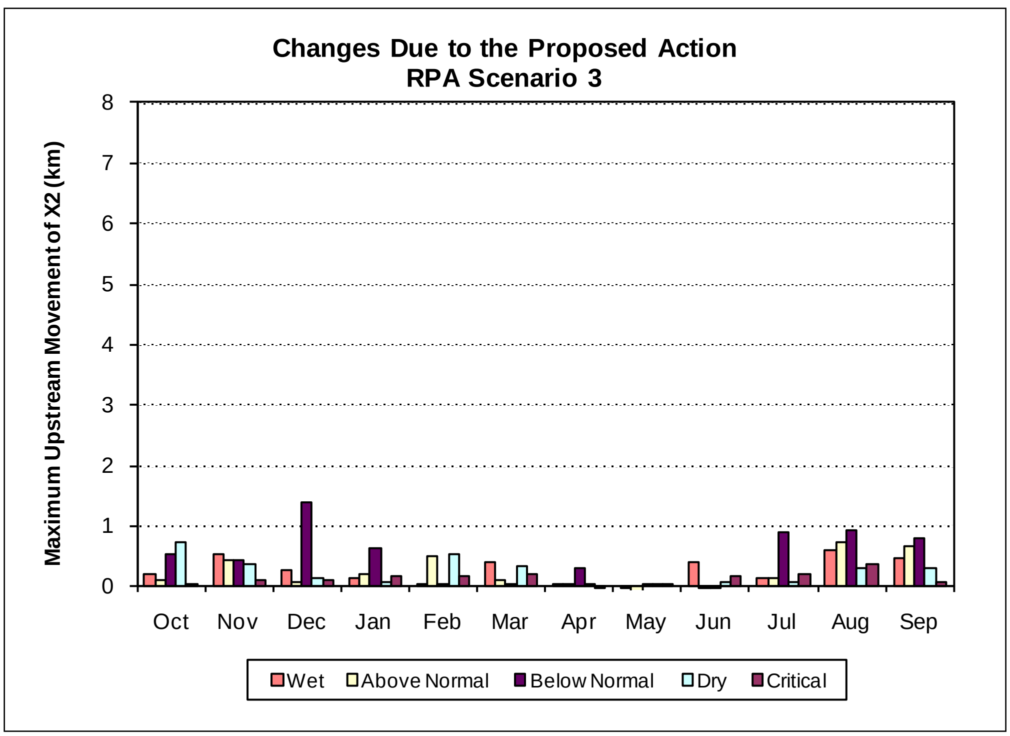




Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

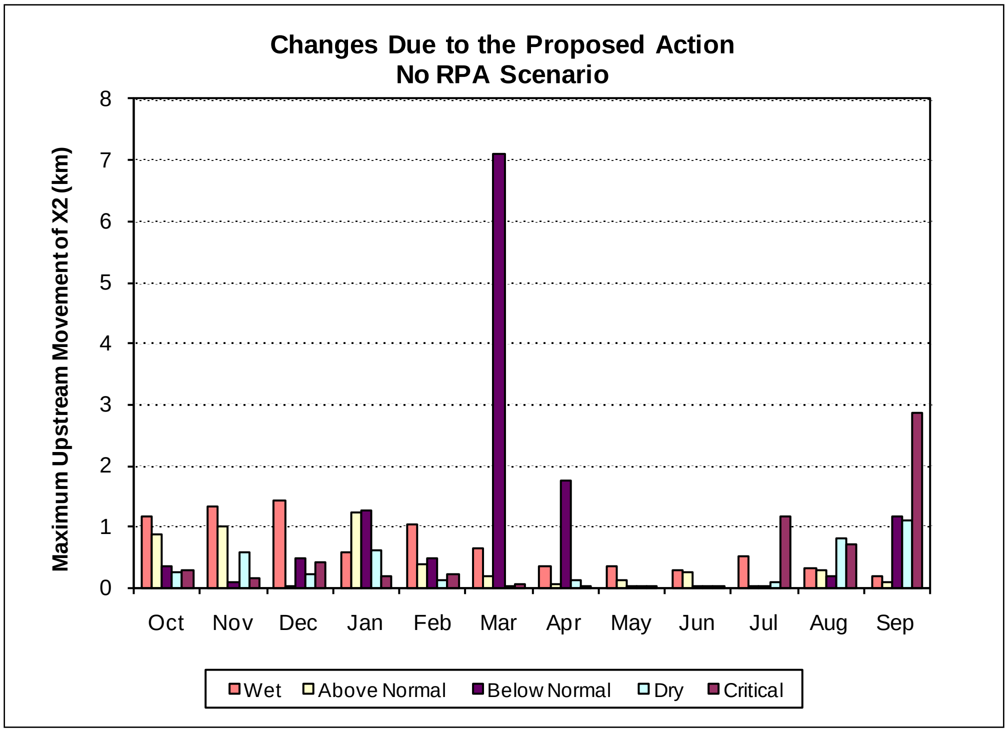
Figure 6.
Maximum Mean Monthly Upstream Shifts in X2 (contd.)

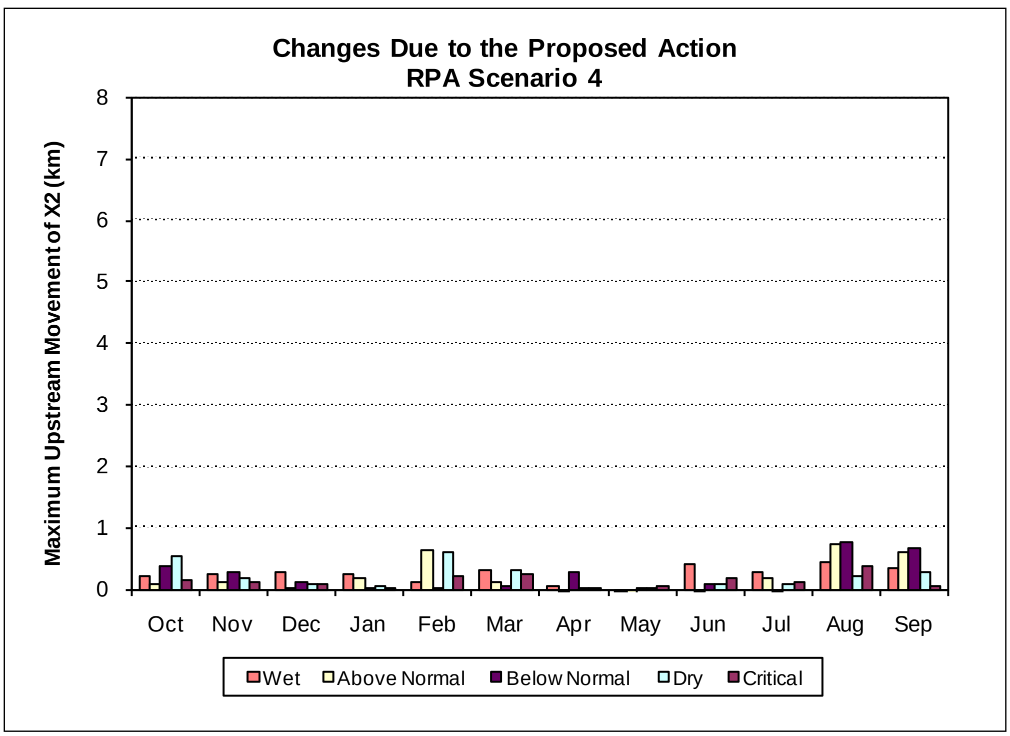




Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

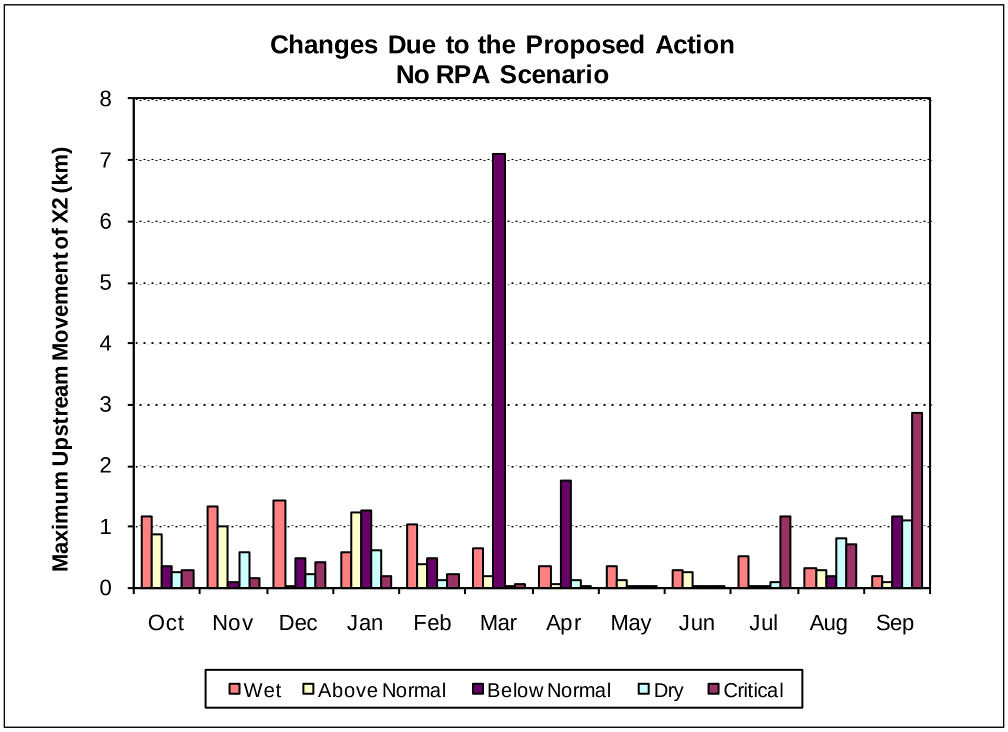
Figure 6.
Maximum Mean Monthly Upstream Shifts in X2 (contd.)

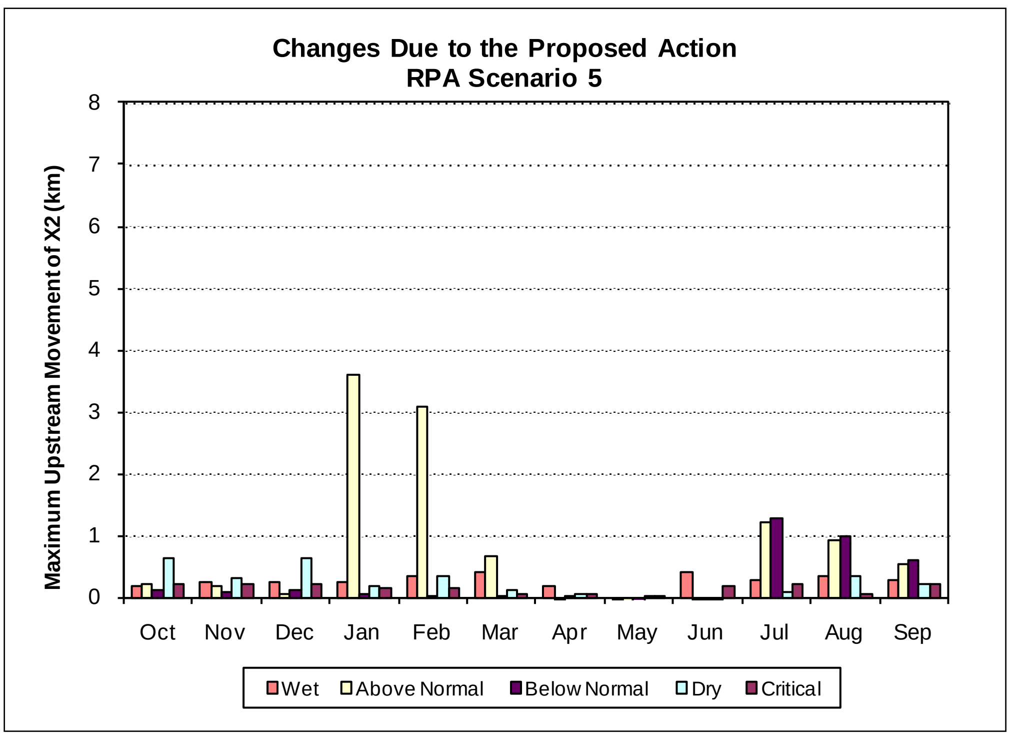




Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

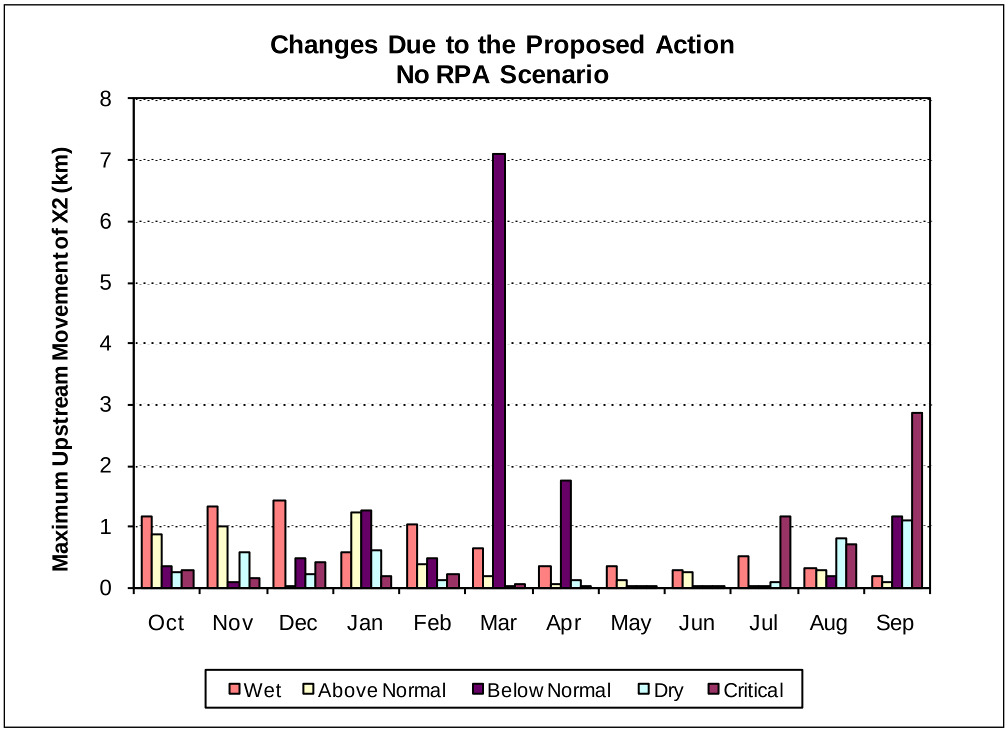
Figure 6.
Maximum Mean Monthly Upstream Shifts in X2 (contd.)

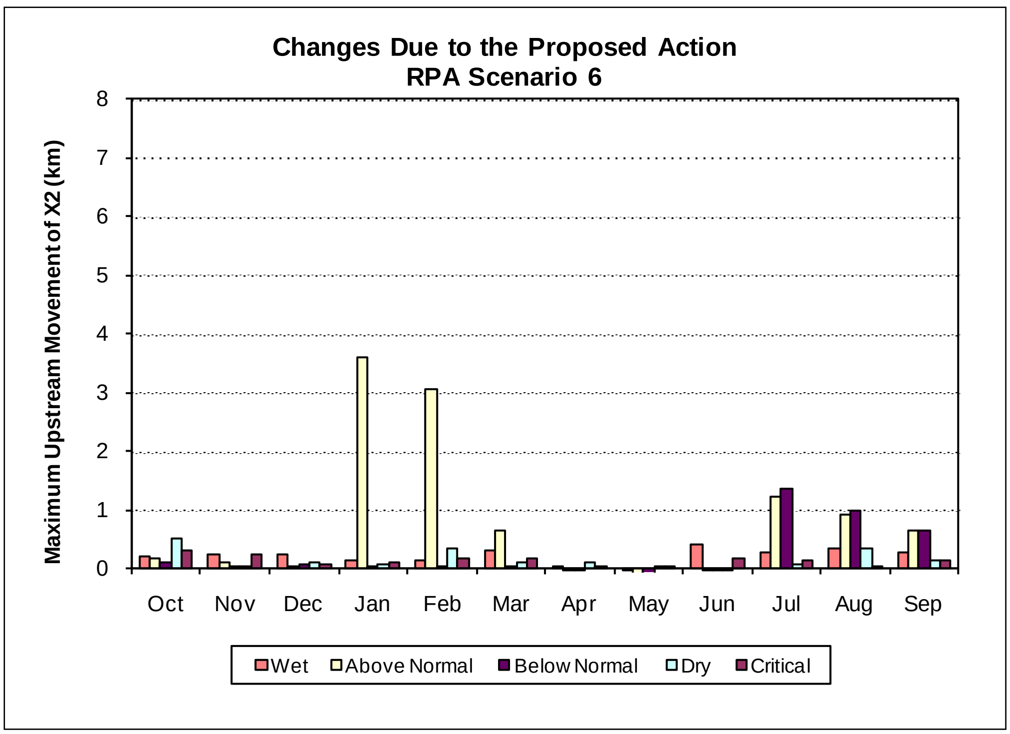




Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

Figure 6.
Maximum Mean Monthly Upstream Shifts in X2 (contd.)





Key:
RPA = reasonable and prudent alternative
km = kilometer
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

Figure 6.
Maximum Mean Monthly Upstream Shifts in X2 (contd.)

Table 9.
Percentage of Years with Upstream Shifts of More Than One Kilometer

	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep
PEIS/R	1	3	0	3	1	3	1	0	0	1	0	4
RPA 1	0	0	4	0	0	0	0	0	0	1	0	0
RPA 2	4	9	2	2	2	9	63	6	7	1	4	6
RPA 3	0	0	3	0	0	0	0	0	0	0	0	0
RPA 4	0	0	0	0	0	0	0	0	0	0	0	0
RPA 5	0	0	0	1	1	0	0	0	0	3	0	0
RPA 6	0	0	0	1	1	0	0	0	0	3	0	0

4.2.7 Delta Summary

For two of the parameters, San Joaquin River flow and X2, differences to the changes between the No RPA scenario and the RPA scenarios would not be expected to change the effects determinations for the listed Delta fish species as identified in the BA. However, some differences of the other four parameters – OMR flows, Jones and Banks diversions, the ratio between San Joaquin River flow and OMR flow, and the ratio of San Joaquin River flow to Jones and Banks diversions – are considered large enough to affect Delta fish species. These changes in these parameters are described below.

For most water year types, April and May reverse OMR flows increased (i.e., were more negative) less frequently under the RPA scenarios than under the No RPA scenario (Figure 3). Similarly, the ratio of San Joaquin River flow to OMR flow increased more frequently in the RPA scenarios (Figure 4). These changes are expected to reduce movement of fish into the south Delta and to reduce vulnerability to entrainment in the Jones and Banks diversions.

The difference in Jones and Banks diversions increased (Figure 2) while the ratio of San Joaquin River flow to diversions decreased (Figure 5) from baseline conditions more often with the RPA scenarios than in the No RPA scenario. The largest increases to the changes occurred in March, April, May, and June, when larval delta smelt and longfin smelt and juvenile steelhead and Chinook salmon are present in the Delta. These are the life stages most vulnerable to entrainment. Results of these sensitivity analyses suggest that the RPA scenarios would result in greater fish entrainment than the No RPA scenario.

The net result of the conflicting effects of the diversions and OMR flows is uncertain. In weighing the relative magnitude of the effects, it should be noted the changes in April and May percentage reductions in the reverse OMR flows for the RPA scenarios were often larger and were more consistent over year types than the April and May increases in diversions. In contrast, Jones and Banks increases in diversions varied considerably with year type, showing greater increases in April of Wet, AN, and Critical years, but lower increases in April of BN and Dry years (Figure 2). However, these increases were calculated for more months than were the reductions in reverse OMR flows, including March and June in addition to April and May.

Table 4 summarizes the change in effects to the listed Delta fish species identified in the RPA scenarios. While these parameters (e.g., San Joaquin River Flow at Vernalis, Jones and Banks Diversion) are not the parameters expressly identified in the BA for the effects determinations, they are directly connected to the effects on the listed fish with respect to such factors as entrainment, predation, and food web support. To that end, the overall effect and change identified in Table 10 is based on each factor as affected by the category.

Table 10.
Summary of the Changes in Effects for the Proposed Action in Each RPA Scenario

RPA Scenario	SJR Flow at Vernalis	OMR Flow	Jones and Banks Diversion	Ratio: SJR to OMR	Ratio: SJR to Diversion	X2
BA (no RPAs)	Beneficial	Beneficial	Adverse	Beneficial	May Affect, Not Likely to Adversely Affect	May Affect, Not Likely to Adversely Affect
Scenario 1	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 2	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 3	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 4	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 5	No Change	No Change	No Change	No Change	No Change	No Change
Scenario 6	No Change	No Change	No Change	No Change	No Change	No Change

Key:
RPA = Reasonable and Prudent Alternative
SJR = San Joaquin River
OMR = Old and Middle rivers
X2 = distance upstream from the Golden Gate Bridge where tidally averaged salinity is equal to 2 parts per thousand

Based on these evaluations, there would be no change in the effects determinations for Delta fish.

5.0 References

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Attachment 1

Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies

Appendix B

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2011

TECHNICAL MEMORANDUM

Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies – DRAFT

PREPARED FOR: California Department of Water Resources

PREPARED BY: CH2M HILL, revised subsequently by DWR and Reclamation

DATE: February 10, 2010

The U.S. Fish and Wildlife Service's (Service) Delta Smelt Biological Opinion (BO) was released on December 15, 2008, in response to the U.S. Bureau of Reclamation's (Reclamation) request for formal consultation with the Service on the coordinated operations of the Central Valley Project (CVP) and State Water Project (SWP) in California.

To develop CALSIM II modeling assumptions for reasonable and prudent alternative actions (RPA) documented in this BO, the California Department of Water Resources (Department) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CALSIM II implementations to represent the RPAs in Existing and Future Condition CALSIM II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the December 15, 2008 BO. Unless otherwise indicated, all descriptive information of the RPAs is taken from Appendix B of the BO.

Table 1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in the Service's BO are based on physical and biological phenomena that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CALSIM II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BO and the limited historical data for some of these factors.

TABLE 1
Meeting Participants

Aaron Miller/Department	Derek Hilts/Service
Steve Ford/Department	Steve Detwiler/Service
Randi Field/Reclamation	Matt Nobriga/CDFG
Gene Lee/Reclamation	Jim White/CDFG
Lenny Grimaldo/Reclamation	Craig Anderson/NMFS
Parviz Nader-Tehrani/Department	Robert Leaf/CH2M HILL
Erik Reyes/Department	Derya Sumer/CH2M HILL
Sean Sou/Department	

Notes:

CDFG = California Department of Fish and Game

NMFS = National Marine Fisheries Service

The simulated Old and Middle River (OMR) flow conditions and CVP and SWP Delta export operations, resulting from these assumptions, are believed to be a reasonable representation of conditions expected to prevail under the RPAs over large spans of years (refer to CALSIM II modeling results for more details on simulated operations). Actual OMR flow conditions and Delta export operations will differ from simulated operations for numerous reasons, including having near real-time knowledge and/or estimates of turbidity, temperature, and fish spatial distribution that are unavailable for use in CALSIM II over a long period of record. Because these factors and others are believed to be critical for smelt entrainment risk management, the Service adopted an adaptive process in defining the RPAs. Given the relatively generalized representation of the RPAs, assumed for CALSIM II modeling, much caution is required when interpreting outputs from the model.

Action 1: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 1 – First Flush)

Action 1 Summary:

Objective: A fixed duration action to protect pre-spawning adult delta smelt from entrainment during the first flush, and to provide advantageous hydrodynamic conditions early in the migration period.

Action: Limit exports so that the average daily Combined OMR flow is no more negative than -2,000 cubic feet per second (cfs) for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent).

Timing:

Part A: December 1 to December 20 – Based upon an examination of turbidity data from Prisoner's Point, Holland Cut, and Victoria Canal and salvage data from CVP/SWP (see below), and other parameters important to the protection of delta smelt including, but not limited to, preceding conditions of X2, the Fall Midwater Trawl Survey (FMWT), and river flows; the SWG may recommend a start date to the Service. The Service will make the final determination.

Part B: After December 20 – The action will begin if the 3-day average turbidity at Prisoner's Point, Holland Cut, and Victoria Canal exceeds 12 nephelometric turbidity units (NTU). However the SWG can recommend a delayed start or interruption based on other conditions such as Delta inflow that may affect vulnerability to entrainment.

Triggers (Part B):

Turbidity: Three-day average of 12 NTU or greater at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

OR

Salvage: Three days of delta smelt salvage after December 20 at either facility or cumulative daily salvage count that is above a risk threshold based upon the "daily salvage index" approach reflected in a daily salvage index value ≥ 0.5 (daily delta smelt salvage > one-half prior year FMWT index value).

The window for triggering Action 1 concludes when either off-ramp condition described below is met. These off-ramp conditions may occur without Action 1 ever being triggered. If this occurs, then Action 3 is triggered, unless the Service concludes on the basis of the totality of available information that Action 2 should be implemented instead.

Off-ramps:

Temperature: Water temperature reaches 12 degrees Celsius (°C) based on a three station daily mean at the temperature stations: Mossdale, Antioch, and Rio Vista

OR

Biological: Onset of spawning (presence of spent females in the Spring Kodiak Trawl Survey [SKT] or at Banks or Jones).

Action 1 Assumptions for CALSIM II Modeling Purposes:

An approach was selected based on hydrologic and assumed turbidity conditions. Under this general assumption, Part A of the action was never assumed because, on the basis of historical salvage data, it was considered unlikely or rarely to occur. Part B of the action was assumed to occur if triggered by turbidity conditions. This approach was believed to tend to a more conservative interpretation of the frequency, timing, and extent of this action. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -2,000 cfs for a total duration of 14 days, with a 5-day running average no more negative than -2,500 cfs (within 25 percent of the monthly criteria).

Timing: If turbidity-trigger conditions first occur in December, then the action starts on December 21; if turbidity-trigger conditions first occur in January, then the action starts on January 1; if turbidity-trigger conditions first occur in February, then the action starts on February 1; and if turbidity-trigger conditions first occur in March, then the action starts on March 1. It is assumed that once the action is triggered, it continues for 14 days.

Triggers: Only an assumed turbidity trigger that is based on hydrologic outputs was considered. A surrogate salvage trigger or indicator was not included because there was no way to model it.

Turbidity: If the monthly average unimpaired Sacramento River Index (four-river index: sum of Sacramento, Yuba, Feather, and American Rivers) exceeds 20,000 cfs, then it is assumed that an event, in which the 3-day average turbidity at Hood exceeds 12 NTU, has occurred within the month. It is assumed that an event at Sacramento River is a reasonable indicator of this condition occurring, within the month, at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal.

A chart showing the relationship between turbidity at Hood (number of days with turbidity is greater than 12 NTU) and Sacramento River Index (sum of monthly flow at four stations on the Sacramento, Feather, Yuba and American Rivers, from 2003 to 2006) is shown on Figure 1. For months when average Sacramento River Index is between 20,000 cfs and 25,000 cfs a transition is observed in number of days with Hood turbidity greater than 12 NTU. For months when average Sacramento River Index is above 25,000 cfs, Hood turbidity was always greater than 12 NTU for as many as 5 days or more within the month in which the flow occurred. For a conservative approach, 20,000 cfs is used as the threshold value.

Salvage: It is assumed that salvage would occur when first flush occurs.

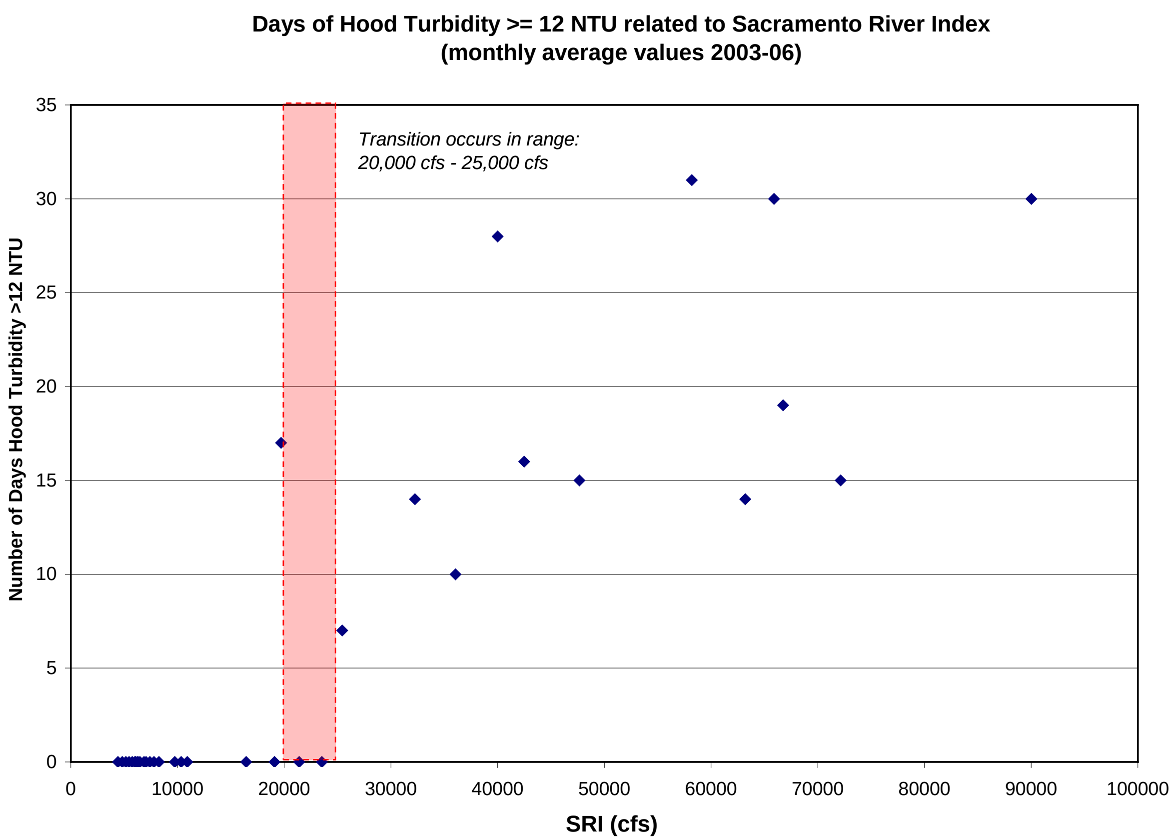

FIGURE 1
RELATIONSHIP BETWEEN TURBIDITY AT HOOD AND SACRAMENTO RIVER INDEX

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (see Figure 2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 2.

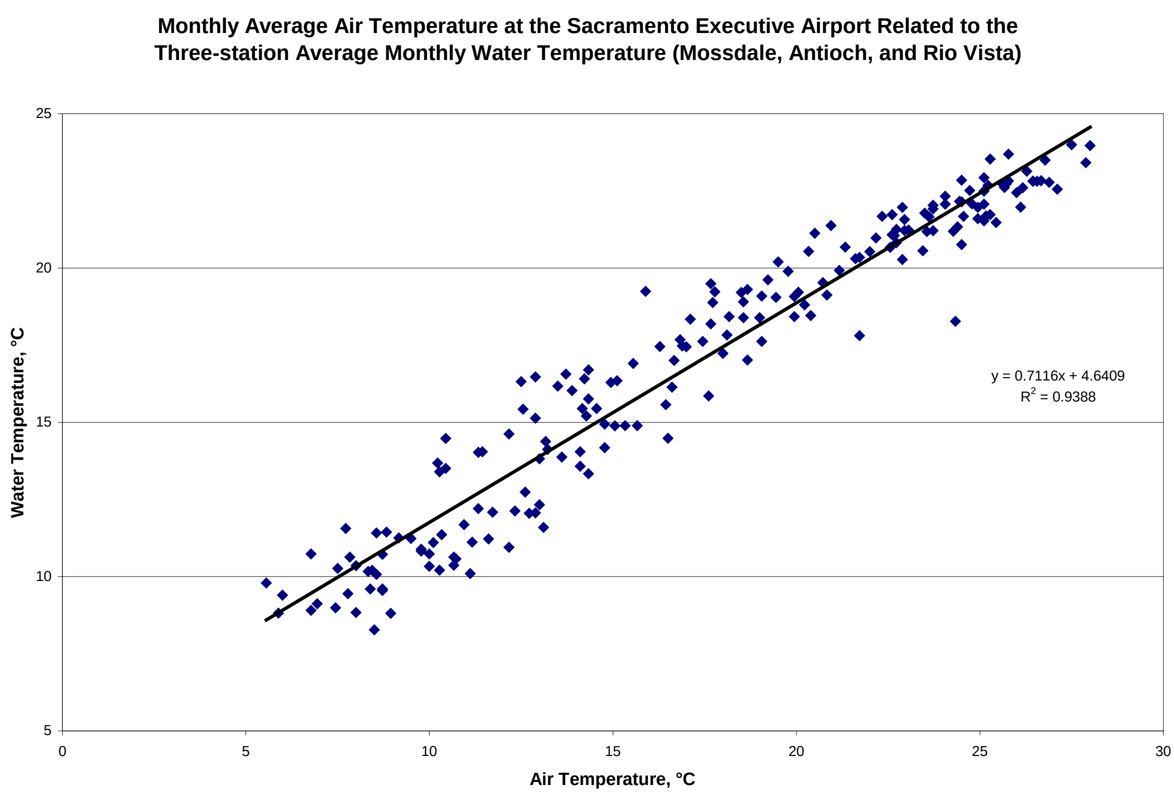

FIGURE 2
RELATIONSHIP BETWEEN MONTHLY AVERAGE AIR TEMPERATURE AT THE SACRAMENTO EXECUTIVE AIRPORT AND THE THREE-STATION AVERAGE MONTHLY WATER TEMPERATURE

Other Modeling Considerations:

In the month of December in which Action 1 does not begin until December 21, for monthly analysis, a background OMR flow must be assumed for the purpose of calculating a day-weighted average for implementing a partial-month action condition. When necessary, the background OMR flow for December was assumed to be -8,000 cfs.

For the additional condition to meet a 5-day running average no more negative than -2,500 cfs (within 25 percent), Paul Hutton's equation[1] is used. Hutton concluded that with stringent OMR standards (1,250 to 2,500 cfs), the 5-day average would control more frequently than the 14-day average, but it is less likely to control at higher flows. Therefore, the CALSIM II implementation includes both a 14-day (approximately monthly average) and a 5-day average flow criteria based on Hutton's methodology (see Attachment 1).

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 1.

December 1 to December 20 for initiating Action 1 is not considered because seasonal peaks of delta smelt salvage are rare prior to December 20. Adult delta smelt spawning migrations often begin following large precipitation events that happen after mid-December.

Salvage of adult delta smelt often corresponds with increases in turbidity and exports. On the basis of the above discussion and Figure 1, Sacramento River Index greater than 25,000 cfs is assumed to be an indicator of turbidity trigger being reached at all three turbidity stations: Prisoner's Point, Holland Cut, and Victoria Canal. Most sediment enters the Delta from the Sacramento River during flow pulses; therefore, a flow indicator based on only Sacramento River flow is used.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CALSIM II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1 will occur 29 times in the December 21 to January 3rd period, 14 times in the January 1 to January 14 period, 13 times in the February 1 to February 14 period, and 17 times in the March 1 to March 14 period. In 3 of these 17 occurrences (1934, 1991, and 2001), Action 3 is triggered before Action 1 and therefore Action 1 is bypassed. Action 1 is not triggered in 9 of the 82 years (1924, 1929, 1931, 1955, 1964, 1976, 1977, 1985, and 1994), typically critically dry years. Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 2: Adult Delta Smelt Migration and Entrainment (RPA Component 1, Action 2)

Action 2 Summary:

Objective: An action implemented using an adaptive process to tailor protection to changing environmental conditions after Action 1. As in Action 1, the intent is to protect

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[1] Hutton, Paul/Metropolitan Water District of Southern California (MWDSC). Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 5. February.

pre-spawning adults from entrainment and, to the extent possible, from adverse hydrodynamic conditions.

Action: The range of net daily OMR flows will be no more negative than -1,250 to -5,000 cfs. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the Service's Smelt Working Group (SWG) from the onset of Action 2 through its termination (see Adaptive Process description in the BO). The SWG would provide weekly recommendations based upon review of the sampling data, from real-time salvage data at the CVP and SWP, and utilizing most up-to-date technological expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The Service will make the final determination.

Timing: Beginning immediately after Action 1. Before this date (in time for operators to implement the flow requirement) the SWG will recommend specific requirement OMR flows based on salvage and on physical and biological data on an ongoing basis. If Action 1 is not implemented, the SWG may recommend a start date for the implementation of Action 2 to protect adult delta smelt.

Suspension of Action:

Flow: OMR flow requirements do not apply whenever a 3-day flow average is greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and 10,000 cfs in San Joaquin River at Vernalis. Once such flows have abated, the OMR flow requirements of the Action are again in place.

Off-ramps:

Temperature: Water temperature reaches 12°C based on a three-station daily average at the temperature stations: Rio Vista, Antioch, and Mossdale.

OR

Biological: Onset of spawning (presence of a spent female in SKT or at either facility).

Action 2 Assumptions for CALSIM II Modeling Purposes:

An approach was selected based on the occurrence of Action 1 and X2 salinity conditions. This approach selects from between two OMR flow tiers depending on the previous month's X2 position, and is never more constraining than an OMR criterion of -3,500 cfs. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -3,500 or -5,000 cfs depending on the previous month's ending X2 location (-3,500 cfs if X2 is east of Roe Island, or -5,000 cfs if X2 is west of Roe Island), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -4,375 cfs if X2 is east of Roe Island, or -6,250 cfs if X2 is west of Roe Island).

Timing: Begins immediately after Action 1 and continues until initiation of Action 3.

In a typical CALSIM II 82-year simulation, Action 1 was not triggered in 9 of the 82 years. In these conditions it is assumed that OMR flow should be maintained no more negative than -5,000 cfs.

Suspension of Action: A flow peaking analysis, developed by Paul Hutton[2], is used to determine the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring within the month. It is assumed that when the likelihood of these conditions occurring exceeds 50 percent, Action 2 is suspended for the full month, and OMR flow requirements do not apply. The likelihood of these conditions occurring is evaluated each month, and Action 2 is suspended for one month at a time whenever both of these conditions occur.

The equations for likelihood (frequency of occurrence) are as follows:

Frequency of Rio Vista 3-day flow average > 90,000 cfs:

> 0% when Freeport monthly flow < 50,000 cfs, OR
>
> (0.00289 x Freeport monthly flow – 146)% when 50,000 cfs ≤ Freeport plus Yolo Bypass monthly flow ≤ 85,000 cfs, OR
>
> 100% when Freeport monthly flow >85,000 cfs

Frequency of Vernalis 3-day flow average > 10,000 cfs:

> 0% when Vernalis monthly flow < 6,000 cfs, OR
>
> (0.00901 x Vernalis monthly flow – 49)% when 6,000 cfs ≤ Vernalis monthly flow ≤ 16,000 cfs, OR
>
> 100% when Vernalis monthly flow >16,000 cfs

Frequency of Rio Vista 3-day flow average > 90,000 cfs equals 50% when Freeport plus Yolo Bypass monthly flow is 67,820 cfs and the frequency of Vernalis 3-day flow average > 10,000 cfs equals 50% Vernalis monthly flow is 10,988 cfs. Therefore these two flow values are used as thresholds in the model.

Off-ramps: Only temperature-based off-ramping is considered. A surrogate biological off-ramp indicator was not included.

<u>Temperature:</u> Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought for use as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air

[2] Hutton, Paul/MWDSC. 2009. Water Supply Impact Analysis of December 2008 Delta Smelt Biological Opinion, Appendix 4. February.

and water temperature, daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 2.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 2.

Action 2 requirements are based on X2 location that is dependent on the Delta outflow. If outflows are very high, fewer delta smelt will spawn east of Sherman Lake; therefore, the need for OMR restrictions is lessened.

In the case of Action 1 not being triggered, CDFG suggested OMR > -5,000 cfs, following the actual implementation of the BO in winter 2009, because some adult delta smelt might move into the Central Delta without a turbidity event.

Action 2 is suspended when the likelihood of a 3-day flow average greater than or equal to 90,000 cfs in Sacramento River at Rio Vista and a 3-day flow average greater than or equal to 10,000 cfs in San Joaquin River at Vernalis occurring concurrently within the month exceeds 50 percent, because at extreme high flows the majority of adult delta smelt will be distributed downstream of the Delta, and entrainment concerns will be very low.

The 12°C threshold for the off-ramp criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

Results: Using these assumptions, in a typical CALSIM II 82-year simulation (1922 through 2003 hydrologic conditions), Action 1, and therefore Action 2, does not occur in 11 of the 82 years (1924, 1929, 1931, 1934, 1955, 1964, 1976, 1977, 1985, 1991, 1994, and 2001), typically critically dry years. The criteria for suspension of OMR minimum flow requirements, described above, results in potential suspension of Action 2 (if Action 2 is active) 6 times in January, 11 times in February, 6 times in March (however Action 2 was not active in 3 of these 6 times), and 2 times in April. The result is that Action 2 is in effect 37 times in January (with OMR at -3,500 cfs 29 times, and at -5,000 cfs 8 times), 43 times in February (with OMR at -3,500 cfs 25 times, and at -5,000 cfs 18 times), 31 times in March (with OMR at -3,500 cfs 14 times, and at -5,000 cfs 17 times), and 80 times in April (with OMR at -3,500 cfs 46 times, and at -5,000 cfs 34 times). The frequency each month is a cumulative result of the action being triggered in the current or prior months. Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest.

Action 3: Entrainment Protection of Larval and Juvenile Delta Smelt (RPA Component 2)

Action 3 Summary:

Objective: Minimize the number of larval delta smelt entrained at the facilities by managing the hydrodynamics in the Central Delta flow levels pumping rates spanning a time sufficient for protection of larval delta smelt, e.g., by using a VAMP-like action. Because protective OMR flow requirements vary over time (especially between years), the action is adaptive and flexible within appropriate constraints.

Action: Net daily OMR flow will be no more negative than -1,250 to -5,000 cfs based on a 14-day running average with a simultaneous 5-day running average within 25 percent of the applicable requirement for OMR. Depending on extant conditions (and the general guidelines below), specific OMR flows within this range are recommended by the SWG from the onset of Action 3 through its termination (see Adaptive Process in Introduction). The SWG would provide these recommendations based upon weekly review of sampling data, from real-time salvage data at the CVP/SWP, and expertise and knowledge relating population status and predicted distribution to monitored physical variables of flow and turbidity. The Service will make the final determination.

Timing: Initiate the action after reaching the triggers below, which are indicative of spawning activity and the probable presence of larval delta smelt in the South and Central Delta. Based upon daily salvage data, the SWG may recommend an earlier start to Action 3. The Service will make the final determination.

Triggers:

Temperature: When temperature reaches 12°C based on a three-station average at the temperature stations: Mossdale, Antioch, and Rio Vista.

OR

Biological: Onset of spawning (presence of spent females in SKT or at either facility).

Off-ramps:

Temporal: June 30;

OR

Temperature: Water temperature reaches a daily average of 25°C for three consecutive days at Clifton Court Forebay.

Action 3 Assumptions for CALSIM II Modeling Purposes:

An approach was selected based on assumed temperature and X2 salinity conditions. This approach selects from among three OMR flow tiers depending on the previous month's X2 position and ranges from an OMR criteria of -1,250 to -5,000 cfs. Because of to the potential low export conditions that could occur at an OMR criterion of -1,250 cfs, a criterion for minimum exports for health and safety is also assumed. The assumptions used for modeling are as follows:

Action: Limit exports so that the average daily OMR flow is no more negative than -1,250, -3,500, or -5,000 cfs, depending on the previous month's ending X2 location (-1,250 cfs if X2 is east of Chipps Island, -5,000 cfs if X2 is west of Roe Island, or -3,500 cfs if X2 is between Chipps and Roe Island, inclusively), with a 5-day running average within 25 percent of the monthly criteria (no more negative than -1,562 cfs if X2 is east of Chipps Island, -6,250 cfs if X2 is west of Roe Island, or -4,375 cfs if X2 is between Chipps and Roe Island). The more constraining of this OMR requirement or the VAMP requirement will be selected during the

VAMP period (April 15 to May 15). Additionally, in the case of the month of June, the OMR criterion from May is maintained through June (it is assumed that June OMR should not be more constraining than May).

Timing: Begins immediately upon temperature trigger conditions and continues until off-ramp conditions are met.

Triggers: Only temperature trigger conditions are considered. A surrogate biological trigger was included.

Temperature: Because the water temperature data at the three temperature stations (Antioch, Mossdale, and Rio Vista) are only available for years after 1984, another parameter was sought to be used as an alternative indicator. It is observed that monthly average air temperature at Sacramento Executive Airport generally trends with the three-station average water temperature (Figure 2). Using this alternative indicator, monthly average air temperature is assumed to occur in the middle of the month, and values are interpolated on a daily basis to obtain daily average water temperature. Using the correlation between air and water temperature, estimated daily water temperatures are estimated from the 82-year monthly average air temperature. Dates when the three-station average temperature reaches 12°C are recorded and used as input in CALSIM. A 1:1 correlation was used for simplicity instead of using the trend line equation illustrated on Figure 2.

Biological: Onset of spawning is assumed to occur no later than April 30.

Off-ramps:

Temporal: It is assumed that the ending date of the action would be no later than June 30.

OR

Temperature: Only 17 years of data are available for Clifton Court water temperature. A similar approach as used in the temperature trigger was considered. However, because 3 consecutive days of water temperature greater than or equal to 25°C is required, a correlation between air temperature and water temperature did not work well for this off-ramp criterion. Out of the 17 recorded years, in one year the criterion was triggered in May (May 31), and in 3 years it was triggered in June (June 3, 21, and 27). In all other years it was observed in July or later. With only four data points before July, it was not possible to generate a rule based on statistics. Therefore, temporal off-ramp criterion (June 30) is used for all years.

Health and Safety: In CALSIM II, a minimum monthly Delta export criterion of 300 cfs for SWP and 600 cfs (or 800 cfs depending on Shasta storage) for CVP is assumed. This assumption is suitable for dry-year conditions when allocations are low and storage releases are limited; however, minimum monthly exports need to be made for protection of public health and safety (health and safety deliveries upstream of San Luis Reservoir).

In consideration of the severe export restrictions associated with the OMR criteria established in the RPAs, an additional set of health and safety criterion is assumed. These export restrictions could lead to a situation in which supplies are available and allocated; however, exports are curtailed forcing San Luis to have an accelerated drawdown rate. For dam safety at San Luis Reservoir, 2 feet per day is the maximum acceptable drawdown rate.

Drawdown occurs faster in summer months and peaks in June when the agricultural demands increase. To avoid rapid drawdown in San Luis Reservoir, a relaxation of OMR is allowed so that exports can be maintained at 1,500 cfs in all months if needed.

This modeling approach may not fit the real-life circumstances. In summer months, especially in June, the assumed 1,500 cfs for health and safety may not be sufficient to keep San Luis drawdown below a safe 2 ft/day; and under such circumstances the projects would be required to increase pumping in order to maintain dam safety.

Rationale: The following is an overall summary of the rationale for the preceding interpretation of RPA Action 3.

The geographic distribution of larval and juvenile delta smelt is tightly linked to X2 (or Delta outflow). Therefore, the percentage of the population likely to be found east of Sherman Lake is also influenced by the location of X2. The X2-based OMR criteria were intended to model an expected management response to the general increase in delta smelt's risk of entrainment as a function of increasing X2.

The 12°C threshold for the trigger criterion is a conservative estimate of when delta smelt larvae begin successfully hatching. Once hatched, the larvae move into the water column where they are potentially vulnerable to entrainment.

The annual salvage "season" for delta smelt typically ends as South Delta water temperatures warm to lethal levels during summer. This usually occurs in late June or early July. The laboratory-derived upper lethal temperature for delta smelt is 25.4°C.

Results: Action 3 occurs 30 times in February (with OMR at -1,250 cfs 9 times, at -3,500 cfs 11 times, and at -5,000 cfs 10 times), 76 times in March (with OMR at -1,250 cfs 15 times, at -3,500 cfs 27 times, and at -5,000 cfs 34 times), all times (82) in April (with OMR at -1,250 cfs 17 times, at -3,500 cfs 29 times, and at -5,000 cfs 35 times), all times (82) in May (with OMR at -1,250 cfs 19 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times), and 70 times in June (with OMR at -1,250 cfs 7 times, at -3,500 cfs 37 times, and at -5,000 cfs 26 times). Refer to CALSIM II modeling results for more details on simulated operations of OMR, Delta exports and other parameters of interest. (Note: The above information is based on the August 2009 version of the model and documents the development process, more recent versions of the model may have different results.)

Action 4: Estuarine Habitat During Fall (RPA Component 3)

Action 4 Summary:

Objective: Improve fall habitat for delta smelt by managing of X2 through increasing Delta outflow during fall when the preceding water year was wetter than normal. This will help return ecological conditions of the estuary to that which occurred in the late 1990s when smelt populations were much larger. Flows provided by this action are expected to provide direct and indirect benefits to delta smelt. Both the direct and indirect benefits to delta smelt are considered equally important to minimize adverse effects.

Action: Subject to adaptive management as described below, provide sufficient Delta outflow to maintain average X2 for September and October no greater (more eastward) than

74 kilometers in the fall following wet years and 81 kilometers in the fall following above normal years. The monthly average X2 position is to be maintained at or seaward of these location for each individual month and not averaged over the two month period. In November, the inflow to CVP/SWP reservoirs in the Sacramento Basin will be added to reservoir releases to provide an added increment of Delta inflow and to augment Delta outflow up to the fall X2 target. The action will be evaluated and may be modified or terminated as determined by the Service.

Timing:

September 1 to November 30.

Triggers:

Wet and above normal water-year type classification from the 1995 Water Quality Control Plan that is used to implement D-1641.

Action 4 Assumptions for CALSIM II Modeling Purposes:

Model is modified to increase Delta outflow to meet monthly average X2 requirements for September and October and subsequent November reservoir release actions in Wet and Above Normal years. No off-ramps are considered for reservoir release capacity constraints. Delta exports may or may not be reduced as part of reservoir operations to meet this action. The Action is summarized in Table 2.

Table 2. Summary of Action 4 implementation in CALSIM II.

Fall Months following Wet or Above Normal Years	**Action Implementation**
September	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
October	Meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)
November	Make reservoir releases up to natural inflow as needed to continue to meet monthly average X2 requirement (74 km in Wet years, 81 km in Above Normal years)

Rationale: Action 4 requirements are based on determining X2 location. Adjustment and retraining of the ANN was also completed to address numerical sensitivity concerns.

Results: There are 38 September and 37 October months that the Action is triggered over the 82-year simulation period.

Action 5: Temporary Spring Head of Old River Barrier and the Temporary Barrier Project (RPA Component 2)

Action 5 Summary:

Objective: To minimize entrainment of larval and juvenile delta smelt at Banks and Jones or from being transported into the South and Central Delta, where they could later become entrained.

Action: Do not install the Spring Head of Old River Barrier (HORB) if delta smelt entrainment is a concern. If installation of the HORB is not allowed, the agricultural barriers would be installed as described in the Project Description. If installation of the HORB is allowed, the Temporary Barrier Project (TBP) flap gates would be tied in the open position until May 15.

Timing: The timing of the action would vary depending on the conditions. The normal installation of the spring temporary HORB and the TBP is in April.

Triggers: For delta smelt, installation of the HORB will only occur when particle tracking modeling results show that entrainment levels of delta smelt will not increase beyond 1 percent at Station 815 as a result of installing the HORB.

Off-ramps: If Action 3 ends or May 15, whichever comes first.

Action 5 Assumptions for CALSIM II and DSM2 Modeling Purposes:

The South Delta Improvement Program (SDIP) Stage 1 is not included in the Existing and Future Condition assumptions being used for CALSIM II and DSM2 baselines. The TBP is assumed instead. The TBP specifies that HORB be installed and operated during April 1 through May 31 and September 16 through November 30. In response to the FWS BO, Action 5, the HORB is assumed to not be installed during April 1 through May 31.

Attachment 2

Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies

Appendix B

SAN JOAQUIN RIVER RESTORATION PROGRAM

November 2011

TECHNICAL MEMORANDUM

Representation of National Marine Fisheries Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies

PREPARED FOR: California Department of Water Resources

PREPARED BY: CH2M HILL, revised subsequently by DWR and Reclamation

DATE: February 10, 2010

The National Marine Fisheries Service's (NMFS) Biological Opinion (BO) on the Long-term Operations of the Central Valley Project and State Water Project was released on June 4, 2009.

To develop CALSIM II modeling assumptions to represent the operations related reasonable and prudent alternative actions (RPA) required by this BO, the California Department of Water Resources (Department) led a series of meetings that involved members of fisheries and project agencies. The purpose for establishing this group was to prepare the assumptions and CALSIM II implementations to represent the RPAs in both Existing- and Future-Condition CALSIM II simulations for future planning studies.

This memorandum summarizes the approach that resulted from these meetings and the modeling assumptions that were laid out by the group. The scope of this memorandum is limited to the June 4, 2009 BO. All descriptive information of the RPAs is taken from the BO.

Table 1 lists the participants that contributed to the meetings and information summarized in this document.

The RPAs in NMFS's BO are based on physical and biological processes that do not lend themselves to simulations using a monthly time step. Much scientific and modeling judgment has been employed to represent the implementation of the RPAs. The group believes the logic put into CALSIM II represents the RPAs as best as possible at this time, given the scientific understanding of environmental factors enumerated in the BO and the limited historical data for some of these factors.

Given the relatively generalized representation of the RPAs assumed for CALSIM II modeling, much caution is required when interpreting outputs from the model.

TABLE 1
Meeting Participants

Aaron Miller/Department Randi Field/Reclamation Lenny Grimaldo/Reclamation Henry Wong/Reclamation	Derek Hilts/USFWS Roger Guinee/ USFWS Matt Nobriga/CDFG Bruce Oppenheim/ NMFS
Parviz Nader-Tehrani/ Department Erik Reyes/ Department Sean Sou/ Department Paul A. Marshall/ Department Ming-Yen Tu/ Department Xiaochun Wang/ Department	Robert Leaf/CH2M HILL Derya Sumer/CH2M HILL

Notes:

CDFG = California Department of Fish and Game

NMFS = National Marine Fisheries Service

USFWS = US Fish and Wildlife Service

Action Suite 1.1 Clear Creek

Suite Objective: The RPA actions described below were developed based on a careful review of past flow studies, current operations, and future climate change scenarios. These actions are necessary to address adverse project effects on flow and water temperature that reduce the viability of spring-run and CV steelhead in Clear Creek.

Action 1.1.1 Spring Attraction Flows

Objective: Encourage spring-run movement to upstream Clear Creek habitat for spawning.

Action: Reclamation shall annually conduct at least two pulse flows in Clear Creek in May and June of at least 600 cfs for at least three days for each pulse, to attract adult spring-run holding in the Sacramento River main stem.

Action 1.1.1 Assumptions for CALSIM II Modeling Purposes

Action: Model is modified to meet 600 cfs for 3 days twice in May. In the CALSIM II analysis, Flows sufficient to increase flow up to 600 cfs for a total of 6 days are added to the flows that would have otherwise occurred in Clear Creek.

Rationale: CALSIM II is a monthly model. The monthly flow in Clear Creek is an underestimate of the the actual flows that would occur subject to daily operational constraints at Whiskeytown Reservoir. The additional flow to meet 600 cfs for a total of 6 days was added to the monthly average flow modeled.

Action 1.1.5. Thermal Stress Reduction

Objective: To reduce thermal stress to over-summering steelhead and spring-run during holding, spawning, and embryo incubation.

Action: Reclamation shall manage Whiskeytown releases to meet a daily water temperature of: 1) 60°F at the Igo gage from June 1 through September 15; and 2) 56°F at the Igo gage from September 15 to October 31.

Action 1.1.5 Assumptions for CALSIM II Modeling Purposes

Action: It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: A temperature model of Whiskeytown Reservoir has been developed by Reclamation. Further analysis using this or other temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model.

Action Suite 1.2 Shasta Operations

Objectives: To address the avoidable and unavoidable adverse effects of Shasta operations on winter-run and spring-run:

1. Ensure a sufficient cold water pool to provide suitable temperatures for winter-run spawning between Balls Ferry and Bend Bridge in most years, without sacrificing the potential for cold water management in a subsequent year. Additional actions to those in the 2004 CVP/SWP operations Opinion are needed, due to increased vulnerability of the population to temperature effects attributable to changes in Trinity River ROD operations, projected climate change hydrology, and increased water demands in the Sacramento River system.
2. Ensure suitable spring-run temperature regimes, especially in September and October. Suitable spring-run temperatures will also partially minimize temperature effects to naturally-spawning, non-listed Sacramento River fall-run, an important prey base for endangered Southern Residents.
3. Establish a second population of winter-run in Battle Creek as soon as possible, to partially compensate for unavoidable project-related effects on the one remaining population.
4. Restore passage at Shasta Reservoir with experimental reintroductions of winter-run to the upper Sacramento and/or McCloud rivers, to partially compensate for unavoidable project-related effects on the remaining population.

Action 1.2.1 Performance Measures

Objective: To establish and operate to a set of performance measures for temperature compliance points and End-of-September (EOS) carryover storage, enabling Reclamation and NMFS to assess the effectiveness of this suite of actions over time. Performance measures will help to ensure that the beneficial variability of the system from changes in hydrology will be measured and maintained.

Action: To ensure a sufficient cold water pool to provide suitable temperatures, long-term performance measures for temperature compliance points and EOS carryover storage at

Shasta Reservoir shall be attained. Performance measures for EOS carryover storage at Shasta Reservoir are as follows:

- 87 percent of years: Minimum EOS storage of 2.2 MAF
- 82 percent of years: Minimum EOS storage of 2.2 MAF and end-of-April storage of 3.8 MAF in following year (to maintain potential to meet Balls Ferry compliance point)
- 40 percent of years: Minimum EOS storage 3.2 MAF (to maintain potential to meet Jelly's Ferry compliance point in following year)

Performance measures (measured as a 10-year running average) for temperature compliance points during summer season are:

- Meet Clear Creek Compliance point 95 percent of time
- Meet Balls Ferry Compliance point 85 percent of time
- Meet Jelly's Ferry Compliance point 40 percent of time
- Meet Bend Bridge Compliance point 15 percent of time

Action 1.2.1 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. System performance will be assessed and evaluated through post-processing of various model results.

Rationale: Given that the performance criteria are based on the CALSIM II modeling data used in preparation of the Biological Assessment, the system performance after application of the RPAs should be similar as a percentage of years that the end-of-April storage and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.2 November through February Keswick Release Schedule (Fall Actions)

Objective: Minimize impacts to listed species and naturally spawning non-listed fall-run from high water temperatures by implementing standard procedures for release of cold water from Shasta Reservoir.

Action: Depending on EOS carryover storage and hydrology, Reclamation shall develop and implement a Keswick release schedule, and reduce deliveries and exports as needed to achieve performance measures.

Action 1.2.2 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. Keswick flows based on operation of 3406(b)(2) releases in OCAP Study 7.1 (for Existing) and Study 8 (for Future) are used in CALSIM II. These flows will be reviewed for appropriateness under this action. A post-process based evaluation similar to what has been explained in Action 1.2.1 will be conducted.

Rationale: Performance measures are set as percentage of years that the end-of-September and temperature compliance requirements are met over the simulation period. Post-processing of modeling results will be compared to various new operating scenarios as needed to evaluate performance criteria and appropriateness of the rules developed.

Action 1.2.3 February Forecast; March – May 14 Keswick Release Schedule (Spring Actions)

Objective: To conserve water in Shasta Reservoir in the spring in order to provide sufficient water to reduce adverse effects of high water temperature in the summer months for winter-run, without sacrificing carryover storage in the fall.

Action: 1) Reclamation shall make its February forecast of deliverable water based on an estimate of precipitation and runoff within the Sacramento River basin at least as conservative as the 90 percent probability of exceedance. Subsequent updates of water delivery commitments must be based on monthly forecasts at least as conservative as the 90 percent probability of exceedance.

2) Reclamation shall make releases to maintain a temperature compliance point not in excess of 56 degrees between Balls Ferry and Bend Bridge from April 15 through May 15.

Action 1.2.3 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model can further verify that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. In the future, it may be that adjusted flow schedules may need to be developed based on development of temperature model runs in conjunction with CALSIM II modeled operations.

Action 1.2.4 May 15 through October Keswick Release Schedule (Summer Action)

Objective: To manage the cold water storage within Shasta Reservoir and make cold water releases from Shasta Reservoir to provide suitable habitat temperatures for winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon in the Sacramento River between Keswick Dam and Bend Bridge, while retaining sufficient carryover storage to manage for next year's cohorts. To the extent feasible, manage for suitable temperatures for naturally spawning fall-run.

Action: Reclamation shall manage operations to achieve daily average water temperatures in the Sacramento River between Keswick Dam and Bend Bridge as follows:

1) Not in excess of 56°F at compliance locations between Balls Ferry and Bend Bridge from May 15 through September 30 for protection of winter-run, and not in excess of 56°F at the same compliance locations between Balls Ferry and Bend Bridge from October 1 through October 31 for protection of mainstem spring run, whenever possible.

2) Reclamation shall operate to a final Temperature Management Plan starting May 15 and ending October 31.

Action 1.2.4 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flows included in model. During the detailed effects analysis, temperature modeling and post-processing will be used to verify temperatures are met at the compliance points. In the long-term approach, for a complete interpretation of the action, development of temperature model runs are needed to develop flow schedules if needed for implementation into CALSIM II.

Rationale: Temperature models of Shasta Lake and the Sacramento River have been developed by Reclamation. This modeling reflects current facilities for temperature controlled releases. Further analysis using this or another temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably at each of the compliance points. It may be that alternative flow schedules may need to be developed based on development of temperature model runs in conjunction with CALSIM II modeled operations.

Action Suite 1.3 Red Bluff Diversion Dam (RBDD) Operations

Objectives: Reduce mortality and delay of adult and juvenile migration of winter-run, spring-run, CV steelhead, and Southern DPS of green sturgeon caused by the presence of the diversion dam and the configuration of the operable gates. Reduce adverse modification of the passage element of critical habitat for these species. Provide unimpeded upstream and downstream fish passage in the long term by raising the gates year-round, and minimize adverse effects of continuing dam operations, while pumps are constructed replace the loss of the diversion structure.

Action 1.3.1 Operations after May 14, 2012: Operate RBDD with Gates Out

Action: No later than May 15, 2012, Reclamation shall operate RBDD with gates out all year to allow unimpeded passage for listed anadromous fish.

Action 1.3.1 Assumptions for CALSIM II Modeling Purposes

Action: Adequate permanent facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the Future condition modeling.

Action 1.3.2 Interim Operations

Action: Until May 14, 2012, Reclamation shall operate RBDD according to the following schedule:

•September 1 - June 14: Gates open. No emergency closures of gates are allowed.

•June 15 - August 31: Gates may be closed at Reclamation's discretion, if necessary to deliver water to TCCA.

Action 1.3.2 Assumptions for CALSIM II Modeling Purposes

Action: Adequate interim/temporary facilities for diversion are assumed; therefore no constraint on diversion schedules is included in the Existing condition modeling.

Action 1.4 Wilkins Slough Operations

Objective: Enhance the ability to manage temperatures for anadromous fish below Shasta Dam by operating Wilkins Slough in the manner that best conserves the dam's cold water pool for summer releases.

Action: The SRTTG shall make recommendations for Wilkins Slough minimum flows for anadromous fish in critically dry years, in lieu of the current 5,000 cfs navigation criterion to NMFS by December 1, 2009. In critically dry years, the SRTTG will make a recommendation.

Action 1.4 Assumptions for CALSIM II Modeling Purposes

Action: Current rules for relaxation of NCP in CALSIM II (based on BA models) will be used. In CALSIM II, NCP flows are relaxed depending on allocations for agricultural contractors. Table 2 is used to determine the relaxation.

TABLE 2

NCP FLOW SCHEDULE WITH RELAXATION

CVP AG Allocation (%)	NCP Flow (cfs)
<10	3250
10-25	3500
25-40	4000
40-65	4500
>65	5000

Rationale: The allocation-flow criteria have been used in the CALSIM II model for many years. The low allocation year relaxations were added to improve operations of Shasta Lake subject to 1.9 MAF carryover target storage. These criteria may be reevaluated subject to the requirements of Action 1.2.1

Action 2.1 Lower American River Flow Management

Objective: To provide minimum flows for all steelhead life stages.

Action: Implement the flow schedule specified in the Water Forum's Flow Management Standard (FMS), which is summarized in Appendix 2-D of the NMFS BO.

Action 2.1 Assumptions for CALSIM II Modeling Purposes

Action: The AFRMP Minimum Release Requirements (MRR) range from 800 to 2,000 cfs based on a sequence of seasonal indices and adjustments. The minimum Nimbus Dam release requirement is determined by applying the appropriate water availability index (Index Flow). Three water availability indices (i.e., Four Reservoir Index (FRI), Sacramento River Index (SRI), and the Impaired Folsom Inflow Index (IFII)) are applied during different times of the year, which provides adaptive flexibility in response to changing hydrological and operational conditions.

During some months, Prescriptive Adjustments may be applied to the Index Flow, resulting in the MRR. If there is no Prescriptive Adjustment, the MRR is equal to the Index Flow.

Discretionary Adjustments for water conservation or fish protection may be applied during the period extending from June through October. If Discretionary Adjustments are applied, then the resultant flows are referred to as the Adjusted Minimum Release Requirement (Adjusted MRR).

The MRR and Adjusted MRR may be suspended in the event of extremely dry conditions, represented by “conference years” or “off-ramp criteria”. Conference years are defined when the projected March through November unimpaired inflow into Folsom Reservoir is less than 400,000 acre-feet. Off-ramp criteria are triggered if forecasted Folsom Reservoir storage at any time during the next twelve months is less than 200,000 acre-feet.

Rationale: Minimum instream flow schedule specified in the Water Forum’s Flow Management Standard (FMS) is implemented in the model.

Action 2.2 Lower American River Temperature Management

Objective: Maintain suitable temperatures to support over-summer rearing of juvenile steelhead in the lower American River.

Action: Reclamation shall develop a temperature management plan that contains: (1) forecasts of hydrology and storage; (2) a modeling run or runs, using these forecasts, demonstrating that the temperature compliance point can be attained (see Coldwater Management Pool Model approach in Appendix 2-D); (3) a plan of operation based on this modeling run that demonstrates that all other non-discretionary requirements are met; and (4) allocations for discretionary deliveries that conform to the plan of operation.

Action 2.2 Assumptions for CALSIM II Modeling Purposes

Action: The flows in the model reflect the ARFMP implemented under Action 2.1. It is assumed that temperature operations can perform reasonably well with flows included in model.

Rationale: Temperature models of Folsom Lake and the American River were developed in the 1990’s. Model development for long range planning purposes may be required. Further analysis using a verified long range planning level temperature model is required to verify the statement that temperature operations can perform reasonably well with flows included in model and temperatures are met reliably

Action Suite 3.1 Stanislaus River / Eastside Division Actions

Overall Objectives: (1) Provide sufficient definition of operational criteria for Eastside Division to ensure viability of the steelhead population on the Stanislaus River, including freshwater migration routes to and from the Delta; and (2) halt or reverse adverse modification of steelhead critical habitat.

Action 3.1.2 Provide Cold Water Releases to Maintain Suitable Steelhead Temperatures

Action: Reclamation shall manage the cold water supply within New Melones Reservoir and make cold water releases from New Melones Reservoir to provide suitable temperatures for CV steelhead rearing, spawning, egg incubation smoltification, and adult migration in the Stanislaus River downstream of Goodwin Dam.

Action 3.1.2 Assumptions for CALSIM II Modeling Purposes

Action: No specific CALSIM II modeling code is implemented to simulate the Performance measures identified. It is assumed that temperature operations can perform reasonably well with flow operations resulting from the minimum flow requirements described in action 3.1.3.

Rationale: Temperature models of New Melones Lake and the Stanislaus River have been developed by Reclamation. Further analysis using this or another temperature model can further verify that temperature operations perform reasonably well with flows included in model and temperatures are met reliably. Development of temperature model runs is needed to refine the flow schedules assumed.

Action 3.1.3 Operate the East Side Division Dams to Meet the Minimum Flows, as Measured at Goodwin Dam

Objective: To maintain minimum base flows to optimize CV steelhead habitat for all life history stages and to incorporate habitat maintaining geomorphic flows in a flow pattern that will provide migratory cues to smolts and facilitate out-migrant smolt movement on declining limb of pulse.

Action: Reclamation shall operate releases from the East Side Division reservoirs to achieve a minimum flow schedule as prescribed in NMFS BO Appendix 2-E and generally described in figure 11-1. When operating at higher flows than specified, Reclamation shall implement ramping rates for flow changes that will avoid stranding and other adverse effects on CV steelhead.

Action 3.1.3 Assumptions for CALSIM II Modeling Purposes

Action: Minimum flows based on Appendix 2-E flows (presented in Figure 1) are assumed consistent to what was modeled by NMFS (5/14/09 and 5/15/09 CALSIM II models provided by NMFS; relevant logic merged into baselines models).

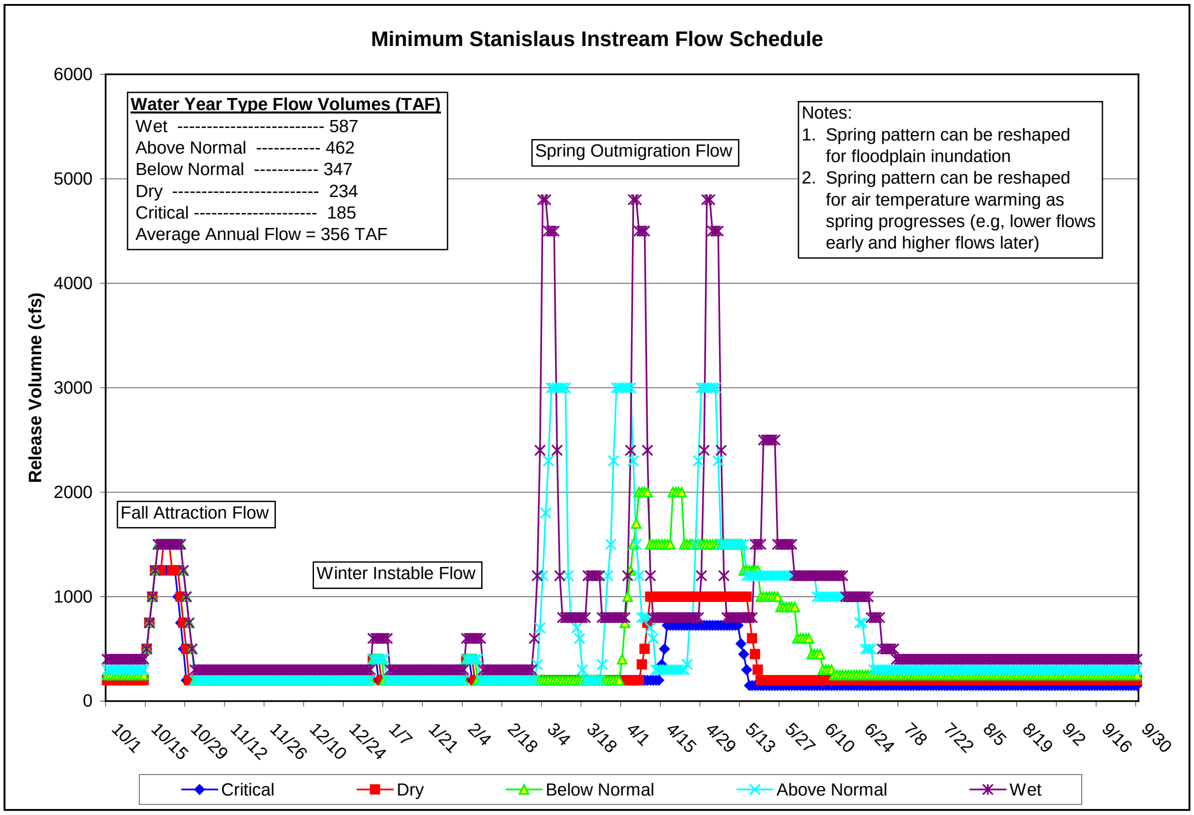

FIGURE 1. MINIMUM STANISLAUS INSTREAM FLOW SCHEDULE AS PRESCRIBED IN APPENDIX 2-E OF THE NMFS BO (06/04/09)

Annual allocation in New Melones is modeled to ensure availability of required instream flows (Table 3) based on a water supply forecast that is comprised of end-of-February New Melones storage (in TAF) plus forecasted inflow to New Melones from March 1 to September 30 (in TAF). The "forecasted inflow" is calculated using perfect foresight in the model. Allocated volume of water is released according to water year type following the monthly flow schedule illustrated in Figure 1.

TABLE 3

NEW MELONES ALLOCATIONS TO MEET MINIMUM INSTREAM FLOW REQUIREMENTS

New Melones index (TAF)	Annual allocation required for instream flows (TAF)
<1000	0-98.9
1,000 - 1,399	98.9
1,400 - 1,724	185.3
1,725 – 2,177	234.1
2,178 - 2,386	346.7
2,387 – 2,761	461.7
2,762 – 6,000	586.9

Rationale: This approach was reviewed by NOAA fisheries and verified that the year typing and New Melones allocation scheme are consistent with the modeling prepared for the BO.

Action Suite 4.1 Delta Cross Channel (DCC) Gate Operation, and Engineering Studies of Methods to Reduce Loss of Salmonids in Georgiana Slough and Interior Delta

Action 4.1.2 DCC Gate Operation

Objective: Modify DCC gate operation to reduce direct and indirect mortality of emigrating juvenile salmonids and green sturgeon in November, December, and January.

Action: During the period between November 1 and June 15, DCC gate operations will be modified from the proposed action to reduce loss of emigrating salmonids and green sturgeon. From December 1 to January 31, the gates will remain closed, except as operations are allowed using the implementation procedures/modified Salmon Decision Tree.

Timing: November 1 through June 15.

Triggers: Action triggers and description of action as defined in NMFS BO are presented in Table 4.

TABLE 4

NMFS BO DCC GATE OPERATION TRIGGERS AND ACTIONS

Date	Action Triggers	Action Responses
October 1 – November 30	Water quality criteria per D-1641 are met and either the Knights Landing Catch Index (KLCI) or the Sacramento Catch Index (SCI) are greater than 3 fish per day but less than or equal to 5 fish per day.	Within 24 hours of trigger, DCC gates are closed. Gates will remain closed for 3 days.
	Water quality criteria per D-1641 are met and either the KLCI or SCI is greater than 5 fish per day	Within 24 hours, close the DCC gates and keep closed until the catch index is less than 3 fish per day at both the Knights Landing and Sacramento monitoring sites.
	The KLCI or SCI triggers are met but water quality criteria are not met per D-1641 criteria.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5.
December 1 – December 14	Water quality criteria are met per D-1641.	DCC gates are closed. If Chinook salmon migration experiments are conducted during this time period (e.g., Delta Action 8 or similar studies), the DCC gates may be opened according to the experimental design, with NMFS' prior approval of the study.
	Water quality criteria are not met but both the KLCI and SCI are less than 3 fish per day.	DCC gates may be opened until the water quality criteria are met. Once water quality criteria are met, the DCC gates will be closed within 24 hours of compliance.
	Water quality criteria are not met but either of the KLCI or SCI is greater than 3 fish per day.	DOSS reviews monitoring data and makes recommendation to NMFS and WOMT per procedures in Action IV.5

TABLE 5 (CONTINUED)

NMFS BO DCC GATE OPERATION TRIGGERS AND ACTIONS

Date	Action Triggers	Action Responses
December 15 – January 31	December 15-January 31	DCC Gates Closed.
	NMFS-approved experiments are being conducted.	Agency sponsoring the experiment may request gate opening for up to five days; NMFS will determine whether opening is consistent with ESA obligations.
	One-time event between December 15 to January 5, when necessary to maintain Delta water quality in response to the astronomical high tide, coupled with low inflow conditions.	Upon concurrence of NMFS, DCC Gates may be opened one hour after sunrise to one hour before sunset, for up to 3 days, then return to full closure. Reclamation and DWR will also reduce Delta exports down to a health and safety level during the period of this action.
February 1 – May 15	D-1641 mandatory gate closure.	Gates closed, per WQCP criteria
May 16 – June 15	D-1641 gate operations criteria	DCC gates may be closed for up to 14 days during this period, per 2006 WQCP, if NMFS determines it is necessary.

Action 4.1.2 Assumptions for CALSIM II Modeling Purposes

Action: The DCC gate operations for October 1 through January 31 were layered on top of the D-1641 gate operations already included in the CALSIM II model. The general assumptions regarding the NMFS DCC operations are summarized in Table 5.

Timing: October 1 through January 31.

TABLE 5

DCC GATE OPERATION TRIGGERS AND ACTIONS AS MODELED IN CALSIM II

Date	Modeled Action Triggers	Modeled Action Responses
October 1-December 14	Sacramento River daily flow at Wilkins Slough exceeding 7,500 cfs; flow assumed to flush salmon into the Delta	Each month, the DCC gates are closed for number of days estimated to exceed the threshold value.
	Water quality conditions at Rock Slough subject to D-1641 standards	Each month, the DCC gates are not closed if it results in violation of the D-1641 standard for Rock Slough; if DCC gates are not closed due to water quality conditions, exports during the days in question are restricted to 2,000 cfs.
December 15 – January 31	December 15-January 31	DCC Gates Closed.

Flow Trigger: It is assumed that during October 1 – December 14, the DCC will be closed if Sacramento River daily flow at Wilkins Slough exceeds 7,500 cfs. Using historical data (1945 through 2003, USGS gauge 11390500 "Sacramento River below Wilkins Slough near Grimes, CA"), a linear relationship is obtained between average monthly flow at Wilkins Slough and the number of days in month where the flow exceeds 7,500 cfs. This relation is then used to estimate the number of days of DCC closure for the October 1 – December 14 time period (Figure 2).

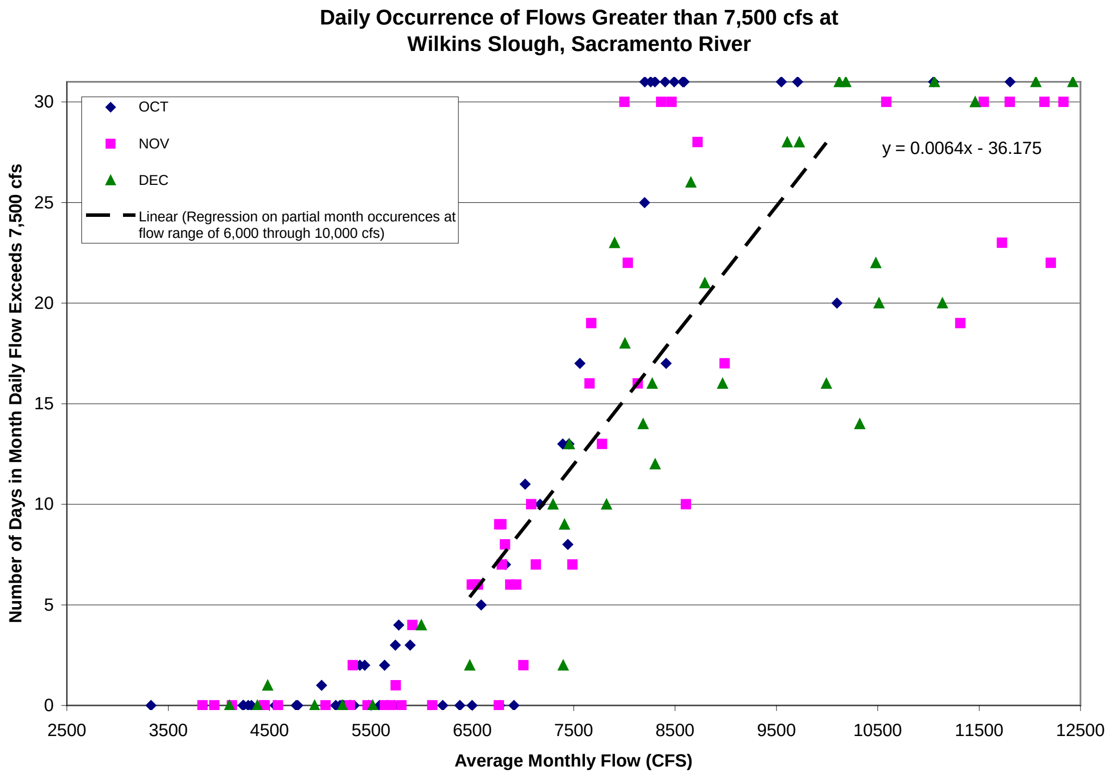

FIGURE 2. RELATIONSHIP BETWEEN MONTHLY AVERAGES OF SACRAMENTO RIVER FLOWS AND NUMBER OF DAYS THAT DAILY FLOW EXCEEDS 7,500 CFS IN A MONTH AT WILKINS SLOUGH

It is assumed that during December 15 through January 31 that the DCC gates are closed under all flow conditions.

Water Quality: It is assumed that during October 1 – December 14 the DCC gates may remain open if water quality is a concern. Using the CALSIM II-ANN flow-salinity model for Rock Slough, current month's chloride level at Rock Slough is estimated assuming DCC closure per NMFS BO. The estimated chloride level is compared against the Rock Slough chloride standard (monthly average). If estimated chloride level exceeds the standard, the gate closure is modeled per D1641 schedule (for the entire month).

It is assumed that during December 15 through January 31 that the DCC gates are closed under all water quality conditions.

Export Restriction: During October 1 – December 14 period, if the flow trigger condition is such that additional days of DCC gates closed is called for, however water quality conditions are a concern and the DCC gates remain open, then Delta exports are limited to 2,000 cfs for each day in question. A monthly Delta export restriction is calculated based on the trigger and water quality conditions described above.

Rationale: The proposed representation in CALSIM II should adequately represent the limited water quality concerns were Sacramento River flows are low during the extreme high tides of December.

Action Suite 4.2 Delta Flow Management

Action 4.2.1 San Joaquin River Inflow to Export Ratio

Objectives: To reduce the vulnerability of emigrating CV steelhead within the lower San Joaquin River to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta, by increasing the inflow to export ratio. To enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the main stem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: For CVP and SWP operations under this action, "The Phase II: Operations beginning is 2012" is assumed. From April 1 through May 31, 1) Reclamation shall continue to implement the Goodwin flow schedule for the Stanislaus River prescribed in Action 3.1.3 and Appendix 2-E of the NMFS BO); and 2) Combined CVP and SWP exports shall be restricted to the ratio depicted in table 6 below based on the applicable San Joaquin River Index, but will be no less than 1,500 cfs (consistent with the health and safety provision governing this action.)

Action 4.2.1 Assumptions for CALSIM II Modeling Purposes

Action: Flows at Vernalis during April and May will be based on the Stanislaus River flow prescribed in Action 3.1.3 and the flow contributions from the rest of the San Joaquin River basin consistent with the representation of VAMP contained in the BA modeling. In many years this flow may be less than the minimum Vernalis flow identified in the NOAA BO.

Exports are restricted as illustrated in Table 6.

TABLE 6

MAXIMUM COMBINED CVP AND SWP EXPORT DURING APRIL AND MAY

San Joaquin River Index	Combined CVP and SWP Export Ratio
Critically dry	1:1
Dry	2:1
Below normal	3:1
Above normal	4:1
Wet	4:1

Rationale: Although the described model representation does not produce the full Vernalis flow objective outlined in the NOAA BO, it does include the elements that are within the control of the CVP and SWP, and that are reasonably certain to occur for the purpose of the EIS/EIR modeling.

In the long-term, a future SWRCB flow standard at Vernalis may potentially incorporate the full flow objective identified in the BO; and the Merced and Tuolumne flows would be based on the outcome of the current SWRCB and FERC processes that are underway.

Action 4.2.3 Old and Middle River Flow Management

Objective: Reduce the vulnerability of emigrating juvenile winter-run, yearling spring-run, and CV steelhead within the lower Sacramento and San Joaquin rivers to entrainment into the channels of the South Delta and at the pumps due to the diversion of water by the export facilities in the South Delta. Enhance the likelihood of salmonids successfully exiting the Delta at Chipps Island by creating more suitable hydraulic conditions in the mainstem of the San Joaquin River for emigrating fish, including greater net downstream flows.

Action: From January 1 through June 15, reduce exports, as necessary, to limit negative flows to -2,500 to -5,000 cfs in Old and Middle Rivers, depending on the presence of salmonids. The reverse flow will be managed within this range to reduce flows toward the pumps during periods of increased salmonid presence. Refer to NMFS BO document for the negative flow objective decision tree.

Action 4.2.3 Assumptions for CALSIM II Modeling Purposes

Action: Old and Middle River flows required in this BO are assumed to be covered by OMR flow requirements developed for actions 1 through 3 of the FWS BO Most Likely scenario (Representation of U.S. Fish and Wildlife Service Biological Opinion Reasonable and Prudent Alternative Actions for CALSIM II Planning Studies – DRAFT, 6/10/09).

Rationale: Based on a review of available data, it appears that implementation of actions 1 through 3 of the FWS RPA, and action 4.2.1 of the NOAA RPA will adequately cover this action within the CALSIM II simulation. If necessary, additional post-processing of results could be conducted to verify this assumption.

Attachment 3

DRAFT Potential Fishery Impacts of San Joaquin River Restoration Sensitivity Analysis

Appendix B

November 2011

Draft

Potential Fishery Impacts of San Joaquin River Restoration Sensitivity Analysis

CalSim Code Implementation
September 3, 2010

Introduction

This Technical Memorandum documents the development of 12 CalSim simulations in support of the Potential Fishery Impacts of San Joaquin River Restoration Sensitivity Analysis.

The sensitivity analysis was developed to investigate the potential for San Joaquin River and Delta fishery impacts of the San Joaquin River Restoration Project (SJRRP) under various implementations of the RPAs to be different than the impacts described in the Draft PEIS/R. The CalSim simulations were developed in an attempt to capture the range of potential operations, and subsequent fishery impacts that could occur under any implementation scheme. As such these simulations were not refined in an attempt to develop "viable" or "reasonable" operations, potentially "unviable" or "unreasonable" operations were left in the simulations if they occurred. The final set of simulations is assumed to define an outer boundary of potential SJRRP impacts given the uncertainty in any final implementation of the RPA's or definition of "viable" or "reasonable" operations. These simulations were then used to attempt to define an outer boundary of potential fishery impacts from any RPA implementation and operational response to the implementation.

These CalSim simulations are intended to represent extremes of operation for fishery analysis purposes; they are not intended to represent Reclamation suggested implementations or Reclamation policy in any form. Use of these simulations for any purpose outside the context of this sensitivity study must be done with a full understanding of the potential that conclusions drawn from such use do not represent Reclamation policy, and may be misleading or factually incorrect.

Baseline Provided by Reclamation

A baseline study labeled "CALSIM_040110_FINAL" was provided by Reclamation. The baseline was an Existing LOD two-step TXFR study. Several global modifications were required to adapt the model for use in the sensitivity analysis.

Single-Step CONV Baseline

To simplify the sensitivity analysis and shorten model runtime, the baseline was condensed into a single-step CONV study. Within the existing structure of CALSIM, the San Joaquin River and tributary operations are completely simulated within the CONV step. Three components of the TXFR step were implemented in the CONV step. This included CVP Cross Valley Canal wheeling through Banks Pumping Plant, CVP Joint Point wheeling through Banks Pumping Plant, and Sacramento County Water Agency diversions of Delta surplus at Freeport. Stage 2 transfers were not included in the CONV step since Stage 2 transfers were turned off in the CALSIM_040110_FINAL TXFR step.

In the baseline provided by Reclamation, Contra Costa Water District Delta diversions were dependent on ANN calculations of salinity at CCWD intakes. ANN calculations of salinity varied from cycle to cycle within the same time-step. This occasionally caused instability in modeling Delta operations from one cycle to the next. In the single-step CONV baseline, CCWD diversions are based on static time-series input from DSM2. This eliminated the cyclical instability.

Comparisons were made between the two-step TXFR and single-step CONV baselines and no significant change in simulated operations was observed. There were occasional small differences in results due to the change in CCWD intake water quality or other modeling noise, but no changes were observed that would affect the conclusions of the sensitivity analysis.

Other Baseline Changes

Missing in the model provided by Reclamation was the implementation of the 2009 BO Vernalis flow RPA (April-May flow requirement at Vernalis). The Vernalis April-May flow RPA was "turned on" by making the following changes to VERNALIS_MIN.WRESL (~~red~~ = deleted text, **blue** = inserted text):

```
define NOAAVernMin_req {!value     0. }
!      case AprORMay {
!           condition month == apr .or. month == may
!           select NOAAmin from NOAAVern60dayMin where WYT = wyt_SJR
}
!      case otherwise {
!           condition always
!           value     0. }
!           }
```

To correct an existing table error, the lookup table NOAAVern60dayMin was edited as follows:

```
! NOAA Phase II RPA flow reqt at Vernalis for Apr1-May31.
NoaaVern60dayMin
WYT    NOAAmin
1      6000
2      6000
3      4500
4      3000
5      601500
```

In VERNALIS_MIN.WRESL, logic for disaggregating April and May Vernalis minimum flow releases was added. Before, with the Vernalis flow RPA "turned off," there was no need to disaggregate the release requirements into April and May pulse and non-pulse periods because the Vernalis minimum flow requirements only applied in the non-pulse period. Now, with the Vernalis flow RPA “turned on,” Vernalis flow requirements cover all of April and May. With differing base releases in the pulse and non-pulse periods, the required releases needed to be calculated separately. The added disaggregation logic, where ‘np’ stands for non-pulse and ‘p’ stands for pulse, is as follows:

```
define VernMin_def_np {
   case AprilorMay {
      condition range(month,apr,may)
      value     max(0., max(NOAAVernMin_req, X2VernMin_req) -
C639[SJR_WQ1])
   }
   case otherwise {
      condition always
      value     max (0., VernMin_req - C639[SJR_WQ1] -
C10DO[VAMP_AND_DO])
   }
}

define VernMin_def_p {
   case AprilorMay {
      condition range(month,apr,may)
      value     max(0., NOAAVernMin_req - C639[VAMP_AND_DO])
   }
   case otherwise {
      condition always
      value     0.
   }
}


define VernMinRemGood_np {
   case AprilMay {
      condition range(month,apr,may)
      value     max(0.,maxGoodwin - C520[SJR_WQ1] + C520F[SJR_WQ1])
   }
   case otherwise {
      condition always
      value     max(0.,maxGoodwin - C520[VAMP_AND_DO] +
C520F[VAMP_AND_DO])
   }
}
define VernMinRemGood_p {
   case AprilMay {
      condition range(month,apr,may)
      value     max(0.,maxGoodwin - C520[VAMP_AND_DO] +
C520F[VAMP_AND_DO])
   }
   case otherwise {
      condition always
      value     0.
```

```
    }
}

define VernMinRel1_np {value min(VernMin_def_np,VernMinRemGood_np)}
define VernMinRel1_p {value min(VernMin_def_p,VernMinRemGood_p)}

define Rel1_np_frac {
    case April {
        condition month == apr .and. VernMinRel1_np + VernMinRel1_p >
0.1
        value
    VernMinRel1_np*cfs_taf*14./30./(VernMinRel1_np*cfs_taf*14./30. +
VernMinRel1_p*cfs_taf*16./30.)
    }
    case May {
        condition month == may .and. VernMinRel1_np + VernMinRel1_p >
0.1
        value
    VernMinRel1_np*cfs_taf*16./31./(VernMinRel1_np*cfs_taf*16./31. +
VernMinRel1_p*cfs_taf*15./31.)
    }
    case otherwise {
        condition always
        value     1.
    }
}


define VernMinCaprem_np {
    case April {
        condition month == apr
        value     Rel1_np_frac*VernMinCapRem*30./14.
    }
    case May {
        condition month == may
        value     Rel1_np_frac*VernMinCapRem*31./16.
    }
    case otherwise {
        condition always
        value     VernMinCapRem
    }
}

define VernMinCaprem_p {
    case April {
        condition month == apr
        value     max(0.,1. - Rel1_np_frac)*VernMinCapRem*30./16.
    }
    case May {
        condition month == may
        value     max(0.,1. - Rel1_np_frac)*VernMinCapRem*31./15.
    }
    case otherwise {
        condition always
```

```
        value      0.
    }
}

define VernMinRel_np {value min(VernMinRel1_np,VernMinCaprem_np)}
define VernMinRel_p {value min(VernMinRel1_p,VernMinCaprem_p)}

!define VernMin_reqtobemet { value min(VernMinRemGoodRipon,
VernMin_def, VernMinCapRem)}
define VernMin_reqtobemet {
        condition month == apr
        value      (14.*VernMinRel_np + 16.*VernMinRel_p)/30.
    }
    case May {
        condition month == may
        value      (16.*VernMinRel_np + 15.*VernMinRel_p)/31.
    }
    case otherwise {
        condition always
        value      VernMinRel_np
    }
}
```

In VERNALIS_MIN.WRESL, calculation of the annual allocation release cap for Vernalis minimum flows was edited so that in February the cap depends on a forward looking New Melones forecast rather than the previous year's New Melones forecast for the ending contract year. The modification provides better consistency with actual operating practice of making releases based on the upcoming year's water supply rather than being bound by the previous year's contract year allocations. The code changes are as follows:

~~define VernMinCap { select VernMinCap from stan_yr given NMF=NMforecast1 use minimum }~~

```
define sumI10_part_feb {
     case February{
          condition   month==FEB
          sum      (i=mar-month,mar-month+6,1) I10(i) * cfs_TAF(i)
     }
     case otherwise {
          condition      always
          value       0.
     }
}

define NMfore_feb_est {
    case February {
        condition month == feb
        value      S10[SJR_WQ1] + sumI10_part_feb
    }
    case otherwise {
        condition always
        value      0.
```

```
    }
}
define NMfore_feb_est_ {alias NMfore_feb_est kind 'forecast' units
'taf'}

define VernMinCap {
    case February {
        condition month == feb
        select      VernMinCap from stan_yr given NMF=NMfore_feb_est
use minimum
    }
    case otherwise {
        condition always
        select      VernMinCap from stan_yr given NMF=NMforecast1 use
minimum
    }
}
```

In WQ_BOUND_DISAG.WRESL, the disaggregated pulse and non-pulse release requirements generated in VERNALIS_MIN.WRESL were inserted into the water quality calculations. The intent was to properly represent the water quality effects of the Vernalis flow RPA during the April and May pulse and non-pulse periods. Furthermore, two decision variables are created in WQ_BOUND_DISAG.WRESL – C10MIN_P and C10MIN_NP – to provide pulse and non-pulse New Melones release output for Vernalis minimum flow requirements.

San Joaquin River Restoration

The sensitivity analysis required each set of assumptions to be tested both with and without SJR Restoration. In the baseline, Restoration is turned off. Turning Restoration on requires several line changes in the study main wresl file: MAINCONV_SA.WRESL. These changes are as follows:

In Cycle 1, change:

```
INCLUDE '..\..\common\sanjoaquin\Friant\SJRR_Rest_off.wresl'
```

To:

```
INCLUDE '..\..\common\sanjoaquin\Friant\SJRR_Rest.wresl'
```

In Cycles 1 and 2, change:

```
INCLUDE[LOCAL]
'..\..\common\sanjoaquin\Friant\SJR_Rest_Req_Off_Local.wresl'
```

To:

```
INCLUDE[LOCAL]
'..\..\common\sanjoaquin\Friant\SJR_Rest_Req_Local.wresl'
```

In Cycles 3, 4, and 5, change:

```
INCLUDE[LOCAL]
'..\..\common\sanjoaquin\Friant\SJR_Rest_Req_Off_Local.wresl'
```

To:

```
INCLUDE[LOCAL]
'..\..\common\sanjoaquin\Friant\SJR_Rest_Pulse_Local.wresl'
```

In Cycles 6, 7, 8, and 9, change:

```
INCLUDE[LOCAL]
'..\..\common\sanjoaquin\Friant\SJR_Rest_Req_Off_Local.wresl'
```

To:

```
INCLUDE[LOCAL] '..\..\common\sanjoaquin\Friant\SJR_Rest_Full.wresl'
```

In addition to the wresl code changes, Friant release requirements are entered as timeseries data in the CalSim SV DSS file. The B-Part names of the timeseries are REST_REQ_P and REST_REQ_NP. P and NP stand for pulse and non-pulse periods respectively.

CalSim Alternative Simulations

Six different alternatives, or sets of assumptions, were identified by Reclamation to be included in the analysis. Each of the alternatives were modeled both with and without the SJRRP included in order to see the impacts of the SJRRP on operations and flows. These alternatives are characterized in the following table with a brief description of each alternatives's intent and salient assumptions following.

Alternative	VAMP	Stanislaus RPA with reference to VAMP	Stockton East Allocations
1	OFF	First	Variable (90 TAF)
2	OFF	First	100% (155 TAF)
3	ON	First	Variable (90 TAF)
4	ON	Last	Variable (90 TAF)
5	ON	First	100% (155 TAF)
6	ON	Last	100% (155 TAF)

Alternative 1

This setting tests a Basin operation that does not include the VAMP component of the SJRA. The underlying operation of the Stanislaus River includes the Baselines model's operation to the 2009 BO, inclusive of releases for the river flow RPA, Vernalis RPA, D1641 flow and water quality objectives, and Stanislaus River dissolved oxygen objectives. The alternative includes SJRA fall releases in the Stanislaus River and Merced River, but does not include an operation for VAMP during April and May. CVP Stanislaus River contractors are provided allocations ranging from zero (0) up to 90 TAF per year based on water supply availability (based on the New Melones Index – "NMI") and is consistent with the EIR/S studies.

VAMP was "turned off" by setting the values in the CalSim lookup table VAMP_REQ.table to zero.

VAMP_REQ
Base requirement DoubleStep

0	0	0
1999	0	0
3199	0	0
4449	0	0
5699	0	0
99999	0	0

The assumption “Stanislaus RPA with reference to VAMP” relates to how VAMP tributary flow contributions are determined. When established as “first”, means basing the VAMP flow target and tributary contributions on an operation (“VAMP existing flow”) that assumes the Stanislaus River flow RPA exists absent VAMP. When established as “last”, the calculation of VAMP existing flow and tributary contributions assumes the Stanisluas River IPO flow exists absent the VAMP, but the RPA flow will be ultimately released subsequent to the VAMP calculation.

To set the Stanislaus RPA “first” in both the pulse and non-pulse periods, the lookup tables that implemented the Goodwin IPO release were replaced with the tables developed by Derek Hilts to implement the pulse and non-pulse RPA. Calls to the non-pulse RPA table are made in Cycles 1 and 2 in STAN_FW_MIN.WRESL. This required the following edits to the baseline (~~red~~ = deleted text, **blue** = inserted text):

```
define stanmin {
    case AprilMay {
        condition month==APR
        select stanfish flow from Stan_monfishrpa given
stanyr=stanfish_yr use linear where month=month}
    case notAprMay {
        condition always
        select flow from stan_rpa given stanyr=stanfish_yr use
linear where month=month}
}
```

(Note that while a conditional statement is applied to maintain consistency with the baseline code, there is no need for a conditional statement since the table call is the same whether the month is April or not.)

Calls to the pulse RPA table are made in Cycles 3, 4 and 5 in Stan_FW_pulse.wresl. The following edit was made to the baseline:

```
define stanpulse {
    case April {
        condition       month == apr
        select          pulse from stan_pulse_rpa given stanyr =
stanfish_yr use linear }
    case May {
        condition       month == may
        select          pulse from stan_pulse_rpa given stanyr =
stanfish_yr use linear }
    case otherwise {
```

```
        condition       always
        value           0. }
        }
```

The variables stanmin and stanpulse form the upper bound of C520_MIF in the non-pulse and pulse periods respectively. The C520_MIF variable is typically associated with Goodwin releases supporting the IPO. For this study it is used for the Stanislaus RPA flow requirements. A variable C10RPA is included in the model for Stanislaus RPA releases when they occur “last.” The wresl file that implements the Stanislaus RPA last is STAN_NMFS_RPA.WRESL. As such, the “include” statement for this file is commented out in SANJOAQUINADDCYC6.WRESL, and the variable C10RPA is set to zero.

```
!    INCLUDE 'Stanislaus\Stan_NMFS_RPA.wresl'
goal setC10RPAcycle6 { C10RPA = 0. }
```

From the baseline, the cap on Stockton East’s CVP Stanislaus River allocations was reduced from 155 TAF to 90 TAF (SEWD 10 TAF, CSJSEWD 80 TAF). This was done using the stan_yr.table from pre 2009 BO studies and renaming it stan_yr_90.table. The file stan_year_90.table was referenced in STANISLAUS_DEMS.WRESL when retrieving annual allocations for SEWD and CSJWCD. For Sensitivity 1, allocations remained variably dependent on the NMI water supply forecast.

In VERNALIS_MIN.WRESL, the baseline reduced Stanislaus releases necessary to meet Vernalis minimum flow requirements by the amount calculated for release for the Stanislaus RPA. When the Stanislaus RPA is “first,” this release is already included in the base flow. So the Vernalis release corrections were removed as follows:

```
define VernMin_def {value max(0., VernMin_def1 - StanNMFSdef)}

define VernMinRemGoodRipon {value max(0., VernMinRemGoodRipon1 -
StanNMFSdef)}
```

Sensitivity 2

The differences between Sensitivity 2 and Sensitivity 1 are CVP Stanislaus River contractor demands and allocations. In Sensitivity 1, contractor allocations of Stanislaus River water were capped at 90 TAF and the allocations varied with the NMI. Whereas in Sensitivity 2, the contractors’ demand and allocations for Stanislaus River water were raised to 155 TAF, and an allocation of 100% of demand was provided every year. The stan_yr.table developed for the 2009 BO studies was modified so that SEWD and CSJWCD receive75 TAF and 80 TAF CVP allocations, respectively, with no conditioning by the state of the NMI. Furthermore, the lookup table URBAN_DEMAND3.TABLE was modified so that the monthly M&I demands for arc D510 summed up to 75 TAF annually.

In STANISLAUS_DEMS.WRESL, the demand constraint for D520_SEWD_PMI was removed allowing the SEWD M&I demands to be entirely controlled at the point of delivery (D510). Furthermore, losses in the SEWD canal (estimated in CalSim as 5% of flow) were assumed to be part of the increased SEWD demand. Therefore, 5% SEWD demand is assumed channel loss and the remaining 95% is assumed to be actual use. This logic was already established for the SEWD agricultural deliveries. The following change to CALAVERAS_DEMS.WRESL was made for the M&I deliveries.

```
! Set City of Stockton/SEWD M&I delivery to meet delivery requirment
goal meet_D510_MI {D510_MI < max(0., demand_D510_MI*taf_cfs)*0.95}
```

In the above statement, demand_D510_MI is the monthly M&I demand for SEWD retrieved from URBAN_DEMAND3.TABLE. As stated previously, the table was updated so that the monthly M&I demands summed up to 75 TAF annually. The 0.95 correction factor recognizes that 5% of the demand ends up lost in arc L509 and the remainder is delivered to the service area.

While SEWD was allocated 100% of demand every year, a trigger was placed in STANISLAUS_DEMS.WRESL to reduce deliveries when there is encroachment on the New Melones minimum power pool. Reclamation provided the assumption for the minimum power pool capacity of 300 TAF. The following additional wresl code incorporated:

```
!No deliveries to SEWD/CSJID if encroaching on power pool.
goal maxdelivD520_PMI { D520_SEWD_PMI + D520_CSJSEWD_PAG < max(0.,
S10(-1) - 300.)*taf_cfs }
```

Sensitivity 3

Sensitivity 3 is the same as Sensitivity 1 except that the VAMP component of the SJRA is "turned on." In this sensitivity VAMP is based upon a calculation assuming the Stanislaus River flow RPA at Goodwin, and the CVP Stanislaus River contractors are allocated a varying 0-90 TAF water supply.

The lookup table VAMP_REQ.TABLE was returned to the original found in the Reclamation provided baseline.

VAMP_REQ

Base	requirement	DoubleStep
0	2000	3200
1999	2000	3200
3199	3200	4450
4449	4450	5700
5699	5700	7000
99999	7000	7000

Sensitivity 4

Sensitivity 4 is like Sensitivity 3 given that the CVP Stanislaus River contractors' allocations vary with the NMI and are capped at 90 TAF, and the VAMP flow requirements are turned on. However, the difference of this setting is that the Stanislaus

RPA is applied before VAMP operations (first) in Sensitivity 3 and after VAMP operations (last) in Sensitivity 4. In result, this protocol can produce Vernalis flows that vary from VAMP flow targets. In summary, the VAMP flow target and tributary contributions are based on a calculation that assumes Goodwin releases are consistent with the IPO. The tributary contributions are "frozen" to this calculation. Then, Goodwin releases will be operated to the 2009 BO Stanislaus River flow RPA which may be higher or lower in flow than the IPO. In the end, the tributary contribution and flow during the VAMP period will approximate the flow that would have occurred under IPO operations; however, the flow at Vernalis may differ from the VAMP flow target by the amount of difference between Goodwin releases under the IPO and the RPA. There were many code changes to accomplish this operation.

For the April non-pulse period (April 1 to April 14), the Cycle 1 and 2 Goodwin minimum flows were set according to the IPO rather than the BO RPA in STAN_FW_MIN.WRESL:

```
define stanmin {
    case AprilMay {
        condition month==APR
        select flow stanfish from Stan_rpamonfish given
stanyr=stanfish_yr use linear where month=month}
    case notAprMay {
        condition always
        select flow from stan_rpa given stanyr=stanfish_yr use
linear where month=month}
}
```

For the April and May pulse period (April 15 – May 15), the Cycle 3, 4, and 5 Goodwin minimum flows were set according to the IPO rather than the BO RPA in STAN_FW_PULSE.WRESL:

```
define stanpulse {
    case April {
        condition       month == apr
        select          pulse from stan_pulse_rpa given stanyr =
stanfish_yr use linear }
    case May {
        condition       month == may
        select          pulse from stan_pulse_rpa given stanyr =
stanfish_yr use linear }
    case otherwise {
        condition       always
        value           0. }
        }
```

In Cycle 6, the file SANJOAQUINADDCYC6.WRESL was edited so that STAN_NMFS_RPA.WRESL was included and C10RPA was not set to zero:

```
!    INCLUDE 'Stanislaus\Stan_NMFS_RPA.wresl'
goal setC10RPAcycle6 { C10RPA = 0. }
```

Changes were made to STAN_NMFS_RPA.WRESL to calculate any flow deficit or surplus when measured against the Stanislaus RPA. The calculated deficit indicates the quantity of release still necessary to meet the Stanislaus RPA. Any calculated surplus indicates that the IPO release could be reduced to the level of the RPA as long as there are no violations of other downstream flow or water quality standards. The deficit and surplus flow calculations were disaggregated into pulse and non-pulse periods to allow for proper accounting of flow and water quality changes.

VERNALIS_MIN.WRESL determines the increase in releases from New Melones to meet minimum flow requirements at Vernalis. For Sensitivity 4, the calculation had to be edited in several locations to properly account for an increase or decrease in release due to applying the RPA last.

In VERNALIS_BOUND.WRESL, a calculation of monthly average Vernalis flow without including the Cycle 6 Vernalis minimum flow requirements is made. If flow at Goodwin as directed by the IPO is in surplus to that specified by the RPA, this term needs to be reduced by the surplus flow calculated in VERNALIS_MIN.WRESL. This modification was applied as follows:

```
define Vern_nomincycle6 {
    case NonPulseNonDO {
        condition   month <= mar
        value       C639[SJR_WQ1] }
    case April {
        condition   month == apr
        value       14.*C639[SJR_WQ1]/30. + 16.*(C639[VAMP_AND_DO] -
StanNMFSsrp_p)/30. }
    case Mayonly {
        condition   month == may
        value       15.*(C639[VAMP_AND_DO] - StanNMFSsrp_p)/31. +
16.*C639[SJR_WQ1]/31. }
    case NonPulsePlusDO {
        condition   always
        value       C639[VAMP_AND_DO] }
        }
```

Likewise, in INSTREAM_BOUND.WRESL, modifications are made to the calculation of average April and May flows for the IPO requirements by reducing the value by the surplus reduction.

WQ_BOUND_DISAG.WRESL was modified for the pulse and non-pulse changes in release from New Melones. Also, two decision variables were created – C10RPA_P and C10RPA_NP – to provide pulse and non-pulse New Melones release output for Stanislaus RPA flows.

Sensitivity 5

Sensitivity 5 is the same as Sensitivity 2 except that VAMP is turned on. The lookup table VAMP_REQ.TABLE was returned to the original settings found in the Reclamation provided baseline.

VAMP_REQ

Base	requirement	DoubleStep
0	2000	3200
1999	2000	3200
3199	3200	4450
4449	4450	5700
5699	5700	7000
99999	7000	7000

Sensitivity 6

The changes from Sensitivity 5 to Sensitivity 6 are the same as those made from Sensitivity 3 to Sensitivity 4. The only difference between Sensitivity 4 and 6 is the CVP Stanislaus River contractor demand and allocation, which is discussed in detail under Sensitivity 2.

Attachment 4

Flow Requirement Tables for Steelhead and Chinook Salmon in the Merced River

Appendix B

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2011

No RPA Scenario

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	619	537	586	543	582	590	619	537	606	548
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	497	693	714	311	327	274	495	693	704	311	327	274
Jan	733	1,462	752	354	306	279	732	1,455	752	354	306	279
Feb	975	2,005	1,124	335	381	282	982	2,005	1,163	335	381	282
Mar	916	1,649	604	584	677	594	919	1,659	604	584	677	596
Apr	1,544	1,624	1,499	1,740	1,786	1,111	1,443	1,543	1,175	1,632	1,796	1,121
May	2,261	3,445	2,162	1,824	1,851	1,274	2,334	3,501	2,380	1,904	1,863	1,272
Jun	2,556	4,347	2,018	1,966	1,945	1,381	2,554	4,338	2,022	1,966	1,945	1,384
Jul	2,421	3,781	2,097	2,012	1,987	1,392	2,425	3,789	2,108	2,012	1,987	1,389
Aug	1,887	2,688	1,894	1,644	1,608	1,100	1,891	2,700	1,895	1,644	1,608	1,103
Sep	909	1,360	953	772	688	479	918	1,378	972	772	688	479

Steelhead and Chinook Incubation and Fry Rearing (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	619	537	586	543	582	590	619	537	606	548
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	497	693	714	311	327	274	495	693	704	311	327	274
Jan	733	1,462	752	354	306	279	732	1,455	752	354	306	279
Feb	975	2,005	1,124	335	381	282	982	2,005	1,163	335	381	282
Mar	916	1,649	604	584	677	594	919	1,659	604	584	677	596
Apr	1,544	1,624	1,499	1,740	1,786	1,111	1,443	1,543	1,175	1,632	1,796	1,121
May	2,261	3,445	2,162	1,824	1,851	1,274	2,334	3,501	2,380	1,904	1,863	1,272
Jun	2,556	4,347	2,018	1,966	1,945	1,381	2,554	4,338	2,022	1,966	1,945	1,384
Jul	2,421	3,781	2,097	2,012	1,987	1,392	2,425	3,789	2,108	2,012	1,987	1,389
Aug	1,887	2,688	1,894	1,644	1,608	1,100	1,891	2,700	1,895	1,644	1,608	1,103
Sep	909	1,360	953	772	688	479	918	1,378	972	772	688	479

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	619	537	586	543	582	590	619	537	606	548
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	497	693	714	311	327	274	495	693	704	311	327	274
Jan	733	1,462	752	354	306	279	732	1,455	752	354	306	279
Feb	975	2,005	1,124	335	381	282	982	2,005	1,163	335	381	282
Mar	916	1,649	604	584	677	594	919	1,659	604	584	677	596
Apr	1,544	1,624	1,499	1,740	1,786	1,111	1,443	1,543	1,175	1,632	1,796	1,121
May	2,261	3,445	2,162	1,824	1,851	1,274	2,334	3,501	2,380	1,904	1,863	1,272
Jun	2,556	4,347	2,018	1,966	1,945	1,381	2,554	4,338	2,022	1,966	1,945	1,384
Jul	2,421	3,781	2,097	2,012	1,987	1,392	2,425	3,789	2,108	2,012	1,987	1,389
Aug	1,887	2,688	1,894	1,644	1,608	1,100	1,891	2,700	1,895	1,644	1,608	1,103
Sep	909	1,360	953	772	688	479	918	1,378	972	772	688	479

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	619	537	586	543	582	590	619	537	606	548
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	497	693	714	311	327	274	495	693	704	311	327	274
Jan	733	1,462	752	354	306	279	732	1,455	752	354	306	279
Feb	975	2,005	1,124	335	381	282	982	2,005	1,163	335	381	282
Mar	916	1,649	604	584	677	594	919	1,659	604	584	677	596
Apr	1,544	1,624	1,499	1,740	1,786	1,111	1,443	1,543	1,175	1,632	1,796	1,121
May	2,261	3,445	2,162	1,824	1,851	1,274	2,334	3,501	2,380	1,904	1,863	1,272
Jun	2,556	4,347	2,018	1,966	1,945	1,381	2,554	4,338	2,022	1,966	1,945	1,384
Jul	2,421	3,781	2,097	2,012	1,987	1,392	2,425	3,789	2,108	2,012	1,987	1,389
Aug	1,887	2,688	1,894	1,644	1,608	1,100	1,891	2,700	1,895	1,644	1,608	1,103
Sep	909	1,360	953	772	688	479	918	1,378	972	772	688	479

No RPA Scenario

Merced River Upstream from San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	491	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	595	783	827	420	431	357	593	783	817	420	431	357
Jan	900	1,687	958	499	435	363	898	1,681	958	499	435	363
Feb	1,157	2,290	1,345	497	473	360	1,164	2,290	1,383	497	473	360
Mar	834	1,849	609	389	343	295	837	1,859	609	389	343	295
Apr	746	1,124	676	728	633	354	640	1,042	354	620	644	338
May	892	2,003	700	409	389	220	965	2,059	917	489	402	219
Jun	924	2,619	294	280	184	139	923	2,610	297	280	184	139
Jul	701	2,004	262	172	126	83	705	2,012	273	172	126	83
Aug	473	1,186	376	128	115	74	477	1,197	377	128	115	74
Sep	271	650	245	76	63	54	280	668	264	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	491	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	595	783	827	420	431	357	593	783	817	420	431	357
Jan	900	1,687	958	499	435	363	898	1,681	958	499	435	363
Feb	1,157	2,290	1,345	497	473	360	1,164	2,290	1,383	497	473	360
Mar	834	1,849	609	389	343	295	837	1,859	609	389	343	295
Apr	746	1,124	676	728	633	354	640	1,042	354	620	644	338
May	892	2,003	700	409	389	220	965	2,059	917	489	402	219
Jun	924	2,619	294	280	184	139	923	2,610	297	280	184	139
Jul	701	2,004	262	172	126	83	705	2,012	273	172	126	83
Aug	473	1,186	376	128	115	74	477	1,197	377	128	115	74
Sep	271	650	245	76	63	54	280	668	264	76	63	54

RPA Scenario 1

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552	587	591	627	539	625	552
Nov	344	385	359	340	321	291	344	385	359	340	321	291
Dec	515	693	806	311	327	275	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552	587	591	627	539	625	552
Nov	344	385	359	340	321	291	344	385	359	340	321	291
Dec	515	693	806	311	327	275	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552	587	591	627	539	625	552
Nov	344	385	359	340	321	291	344	385	359	340	321	291
Dec	515	693	806	311	327	275	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552	587	591	627	539	625	552
Nov	344	385	359	340	321	291	344	385	359	340	321	291
Dec	515	693	806	311	327	275	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504	931	1,378	1,017	772	688	504

RPA Scenario 1

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408
Nov	437	479	497	429	407	348
Dec	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	96
Aug	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408
Nov	437	479	497	429	407	348
Dec	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	94
Aug	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408
Nov	437	479	497	429	407	348
Dec	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	96
Aug	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408
Nov	437	479	497	429	407	348
Dec	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	94
Aug	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54

RPA Scenario 2

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,452
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	587	591	627	539	625	552
Nov	344	385	359	340	321	291
Dec	515	693	806	311	327	275
Jan	765	1,555	760	366	306	280
Feb	1,036	2,082	1,293	366	382	284
Mar	954	1,726	644	584	677	631
Apr	1,301	1,537	1,163	1,291	1,387	1,022
May	2,194	3,433	2,100	1,639	1,689	1,289
Jun	2,599	4,414	2,063	1,966	1,945	1,458
Jul	2,457	3,835	2,140	2,012	1,987	1,451
Aug	1,905	2,700	1,923	1,644	1,608	1,146
Sep	931	1,378	1,017	772	688	504

RPA Scenario 2

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408	459	484	483	378	529	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	613	783	918	420	431	357	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	96	727	2,058	304	172	126	94
Aug	484	1,197	405	128	115	80	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54	288	668	309	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	459	484	483	378	529	408	459	484	483	378	529	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	613	783	918	420	431	357	613	783	918	420	431	357
Jan	931	1,781	965	511	435	363	931	1,781	965	511	435	363
Feb	1,217	2,368	1,514	528	474	360	1,217	2,368	1,514	528	474	360
Mar	864	1,926	649	389	343	295	864	1,926	649	389	343	295
Apr	486	1,037	341	279	234	178	486	1,037	341	279	234	178
May	810	1,991	638	224	228	160	810	1,991	638	224	228	160
Jun	953	2,686	338	280	184	141	953	2,686	338	280	184	141
Jul	727	2,058	304	172	126	96	727	2,058	304	172	126	94
Aug	484	1,197	405	128	115	80	484	1,197	405	128	115	80
Sep	288	668	309	76	63	54	288	668	309	76	63	54

RPA Scenario 3

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	578	589	618	537	589	548	580	590	619	537	606	539
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	499	693	726	311	327	274	499	693	726	311	327	274
Jan	735	1,467	752	354	306	279	725	1,433	752	354	306	279
Feb	972	1,996	1,123	335	381	282	982	2,005	1,164	335	381	282
Mar	919	1,658	604	584	677	593	917	1,657	604	584	677	583
Apr	1,524	1,623	1,502	1,647	1,739	1,121	1,438	1,543	1,174	1,633	1,727	1,153
May	2,260	3,444	2,173	1,816	1,854	1,260	2,340	3,499	2,414	1,889	1,881	1,266
Jun	2,559	4,350	2,025	1,966	1,945	1,390	2,554	4,339	2,019	1,966	1,945	1,385
Jul	2,423	3,781	2,101	2,012	1,987	1,397	2,425	3,791	2,106	2,012	1,987	1,389
Aug	1,886	2,688	1,891	1,644	1,608	1,102	1,892	2,700	1,892	1,644	1,608	1,111
Sep	909	1,360	953	772	688	479	916	1,378	969	772	688	474

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	578	589	618	537	589	548	580	590	619	537	606	539
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	499	693	726	311	327	274	499	693	726	311	327	274
Jan	735	1,467	752	354	306	279	725	1,433	752	354	306	279
Feb	972	1,996	1,123	335	381	282	982	2,005	1,164	335	381	282
Mar	919	1,658	604	584	677	593	917	1,657	604	584	677	583
Apr	1,524	1,623	1,502	1,647	1,739	1,121	1,438	1,543	1,174	1,633	1,727	1,153
May	2,260	3,444	2,173	1,816	1,854	1,260	2,340	3,499	2,414	1,889	1,881	1,266
Jun	2,559	4,350	2,025	1,966	1,945	1,390	2,554	4,339	2,019	1,966	1,945	1,385
Jul	2,423	3,781	2,101	2,012	1,987	1,397	2,425	3,791	2,106	2,012	1,987	1,389
Aug	1,886	2,688	1,891	1,644	1,608	1,102	1,892	2,700	1,892	1,644	1,608	1,111
Sep	909	1,360	953	772	688	479	916	1,378	969	772	688	474

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	578	589	618	537	589	548	580	590	619	537	606	539
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	499	693	726	311	327	274	499	693	726	311	327	274
Jan	735	1,467	752	354	306	279	725	1,433	752	354	306	279
Feb	972	1,996	1,123	335	381	282	982	2,005	1,164	335	381	282
Mar	919	1,658	604	584	677	593	917	1,657	604	584	677	583
Apr	1,524	1,623	1,502	1,647	1,739	1,121	1,438	1,543	1,174	1,633	1,727	1,153
May	2,260	3,444	2,173	1,816	1,854	1,260	2,340	3,499	2,414	1,889	1,881	1,266
Jun	2,559	4,350	2,025	1,966	1,945	1,390	2,554	4,339	2,019	1,966	1,945	1,385
Jul	2,423	3,781	2,101	2,012	1,987	1,397	2,425	3,791	2,106	2,012	1,987	1,389
Aug	1,886	2,688	1,891	1,644	1,608	1,102	1,892	2,700	1,892	1,644	1,608	1,111
Sep	909	1,360	953	772	688	479	916	1,378	969	772	688	474

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	578	589	618	537	589	548	580	590	619	537	606	539
Nov	344	385	358	341	321	289	344	385	358	341	321	289
Dec	499	693	726	311	327	274	499	693	726	311	327	274
Jan	735	1,467	752	354	306	279	725	1,433	752	354	306	279
Feb	972	1,996	1,123	335	381	282	982	2,005	1,164	335	381	282
Mar	919	1,658	604	584	677	593	917	1,657	604	584	677	583
Apr	1,524	1,623	1,502	1,647	1,739	1,121	1,438	1,543	1,174	1,633	1,727	1,153
May	2,260	3,444	2,173	1,816	1,854	1,260	2,340	3,499	2,414	1,889	1,881	1,266
Jun	2,559	4,350	2,025	1,966	1,945	1,390	2,554	4,339	2,019	1,966	1,945	1,385
Jul	2,423	3,781	2,101	2,012	1,987	1,397	2,425	3,791	2,106	2,012	1,987	1,389
Aug	1,886	2,688	1,891	1,644	1,608	1,102	1,892	2,700	1,892	1,644	1,608	1,111
Sep	909	1,360	953	772	688	479	916	1,378	969	772	688	474

RPA Scenario 3

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	454	484	483	378	494	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	598	783	840	420	431	357	597	783	839	420	431	357
Jan	901	1,692	958	499	435	363	891	1,658	958	499	435	363
Feb	1,154	2,282	1,344	497	473	360	1,164	2,290	1,385	497	473	360
Mar	837	1,859	609	389	343	295	836	1,858	609	389	343	295
Apr	727	1,122	680	635	586	372	639	1,042	352	622	574	389
May	890	2,002	711	401	392	204	972	2,057	951	474	419	218
Jun	927	2,622	300	280	184	141	923	2,611	294	280	184	141
Jul	704	2,004	266	172	126	97	708	2,014	270	172	126	95
Aug	474	1,185	373	128	115	81	478	1,197	374	128	115	80
Sep	271	650	245	76	63	54	279	668	261	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	454	484	483	378	494	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	598	783	840	420	431	357	597	783	839	420	431	357
Jan	901	1,692	958	499	435	363	891	1,658	958	499	435	363
Feb	1,154	2,282	1,344	497	473	360	1,164	2,290	1,385	497	473	360
Mar	837	1,859	609	389	343	295	836	1,858	609	389	343	295
Apr	727	1,122	680	635	586	372	639	1,042	352	622	574	389
May	890	2,002	711	401	392	204	972	2,057	951	474	419	218
Jun	927	2,622	300	280	184	141	923	2,611	294	280	184	141
Jul	704	2,004	266	172	126	97	708	2,014	270	172	126	95
Aug	474	1,185	373	128	115	81	478	1,197	374	128	115	80
Sep	271	650	245	76	63	54	279	668	261	76	63	54

RPA Scenario 4

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	538	587	541	581	590	619	538	606	544
Nov	344	385	358	341	321	289	344	385	358	341	321	290
Dec	497	693	715	311	327	274	494	693	699	311	327	274
Jan	731	1,452	752	354	306	279	728	1,442	752	354	306	279
Feb	974	2,005	1,124	335	381	282	982	2,005	1,161	335	381	282
Mar	919	1,650	604	584	677	604	919	1,660	604	584	677	593
Apr	1,532	1,641	1,482	1,680	1,812	1,072	1,431	1,542	1,175	1,636	1,794	1,059
May	2,260	3,453	2,136	1,804	1,868	1,283	2,330	3,509	2,346	1,885	1,869	1,282
Jun	2,549	4,321	2,018	1,966	1,945	1,387	2,555	4,338	2,022	1,966	1,945	1,387
Jul	2,434	3,805	2,117	2,012	1,987	1,400	2,436	3,812	2,119	2,012	1,987	1,396
Aug	1,887	2,688	1,894	1,644	1,608	1,104	1,893	2,700	1,895	1,644	1,608	1,117
Sep	909	1,360	953	772	688	481	920	1,378	972	772	688	490

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	538	587	541	581	590	619	538	606	544
Nov	344	385	358	341	321	289	344	385	358	341	321	290
Dec	497	693	715	311	327	274	494	693	699	311	327	274
Jan	731	1,452	752	354	306	279	728	1,442	752	354	306	279
Feb	974	2,005	1,124	335	381	282	982	2,005	1,161	335	381	282
Mar	919	1,650	604	584	677	604	919	1,660	604	584	677	593
Apr	1,532	1,641	1,482	1,680	1,812	1,072	1,431	1,542	1,175	1,636	1,794	1,059
May	2,260	3,453	2,136	1,804	1,868	1,283	2,330	3,509	2,346	1,885	1,869	1,282
Jun	2,549	4,321	2,018	1,966	1,945	1,387	2,555	4,338	2,022	1,966	1,945	1,387
Jul	2,434	3,805	2,117	2,012	1,987	1,400	2,436	3,812	2,119	2,012	1,987	1,396
Aug	1,887	2,688	1,894	1,644	1,608	1,104	1,893	2,700	1,895	1,644	1,608	1,117
Sep	909	1,360	953	772	688	481	920	1,378	972	772	688	490

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	538	587	541	581	590	619	538	606	544
Nov	344	385	358	341	321	289	344	385	358	341	321	290
Dec	497	693	715	311	327	274	494	693	699	311	327	274
Jan	731	1,452	752	354	306	279	728	1,442	752	354	306	279
Feb	974	2,005	1,124	335	381	282	982	2,005	1,161	335	381	282
Mar	919	1,650	604	584	677	604	919	1,660	604	584	677	593
Apr	1,532	1,641	1,482	1,680	1,812	1,072	1,431	1,542	1,175	1,636	1,794	1,059
May	2,260	3,453	2,136	1,804	1,868	1,283	2,330	3,509	2,346	1,885	1,869	1,282
Jun	2,549	4,321	2,018	1,966	1,945	1,387	2,555	4,338	2,022	1,966	1,945	1,387
Jul	2,434	3,805	2,117	2,012	1,987	1,400	2,436	3,812	2,119	2,012	1,987	1,396
Aug	1,887	2,688	1,894	1,644	1,608	1,104	1,893	2,700	1,895	1,644	1,608	1,117
Sep	909	1,360	953	772	688	481	920	1,378	972	772	688	490

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	538	587	541	581	590	619	538	606	544
Nov	344	385	358	341	321	289	344	385	358	341	321	290
Dec	497	693	715	311	327	274	494	693	699	311	327	274
Jan	731	1,452	752	354	306	279	728	1,442	752	354	306	279
Feb	974	2,005	1,124	335	381	282	982	2,005	1,161	335	381	282
Mar	919	1,650	604	584	677	604	919	1,660	604	584	677	593
Apr	1,532	1,641	1,482	1,680	1,812	1,072	1,431	1,542	1,175	1,636	1,794	1,059
May	2,260	3,453	2,136	1,804	1,868	1,283	2,330	3,509	2,346	1,885	1,869	1,282
Jun	2,549	4,321	2,018	1,966	1,945	1,387	2,555	4,338	2,022	1,966	1,945	1,387
Jul	2,434	3,805	2,117	2,012	1,987	1,400	2,436	3,812	2,119	2,012	1,987	1,396
Aug	1,887	2,688	1,894	1,644	1,608	1,104	1,893	2,700	1,895	1,644	1,608	1,117
Sep	909	1,360	953	772	688	481	920	1,378	972	772	688	490

RPA Scenario 4

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	492	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	595	783	828	420	431	357	592	783	812	420	431	357
Jan	897	1,678	958	499	435	363	894	1,668	958	499	435	363
Feb	1,157	2,290	1,344	497	473	360	1,164	2,290	1,382	497	473	360
Mar	834	1,850	609	389	343	295	837	1,860	609	389	343	295
Apr	738	1,141	660	668	659	333	632	1,042	354	625	641	292
May	888	2,011	673	389	406	214	958	2,067	884	469	407	214
Jun	917	2,593	294	280	184	141	923	2,610	297	280	184	141
Jul	715	2,028	282	172	126	97	717	2,035	284	172	126	94
Aug	475	1,186	376	128	115	81	478	1,197	377	128	115	80
Sep	271	650	245	76	63	54	280	668	264	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	492	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	595	783	828	420	431	357	592	783	812	420	431	357
Jan	897	1,678	958	499	435	363	894	1,668	958	499	435	363
Feb	1,157	2,290	1,344	497	473	360	1,164	2,290	1,382	497	473	360
Mar	834	1,850	609	389	343	295	837	1,860	609	389	343	295
Apr	738	1,141	660	668	659	333	632	1,042	354	625	641	292
May	888	2,011	673	389	406	214	958	2,067	884	469	407	214
Jun	917	2,593	294	280	184	141	923	2,610	297	280	184	141
Jul	715	2,028	282	172	126	97	717	2,035	284	172	126	94
Aug	475	1,186	376	128	115	81	478	1,197	377	128	115	80
Sep	271	650	245	76	63	54	280	668	264	76	63	54

RPA Scenario 5

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	589	543
Nov	344	385	358	341	321	289
Dec	494	693	701	311	327	274
Jan	729	1,448	752	354	306	279
Feb	976	2,009	1,123	335	381	282
Mar	915	1,644	604	584	677	593
Apr	1,542	1,634	1,504	1,702	1,756	1,140
May	2,259	3,441	2,182	1,821	1,835	1,263
Jun	2,558	4,347	2,032	1,966	1,945	1,380
Jul	2,421	3,781	2,092	2,012	1,987	1,396
Aug	1,885	2,683	1,895	1,644	1,608	1,100
Sep	909	1,360	953	772	688	478

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	579	590	619	537	606	537
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	725	1,433	752	354	306	279
Feb	981	1,999	1,164	335	381	282
Mar	917	1,659	604	584	677	585
Apr	1,449	1,543	1,174	1,641	1,794	1,147
May	2,343	3,507	2,428	1,928	1,829	1,266
Jun	2,551	4,336	2,019	1,966	1,945	1,374
Jul	2,421	3,783	2,096	2,012	1,987	1,389
Aug	1,892	2,700	1,892	1,644	1,608	1,110
Sep	916	1,378	969	772	688	473

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	589	543
Nov	344	385	358	341	321	289
Dec	494	693	701	311	327	274
Jan	729	1,448	752	354	306	279
Feb	976	2,009	1,123	335	381	282
Mar	915	1,644	604	584	677	593
Apr	1,542	1,634	1,504	1,702	1,756	1,140
May	2,259	3,441	2,182	1,821	1,835	1,263
Jun	2,558	4,347	2,032	1,966	1,945	1,380
Jul	2,421	3,781	2,092	2,012	1,987	1,396
Aug	1,885	2,683	1,895	1,644	1,608	1,100
Sep	909	1,360	953	772	688	478

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	579	590	619	537	606	537
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	725	1,433	752	354	306	279
Feb	981	1,999	1,164	335	381	282
Mar	917	1,659	604	584	677	585
Apr	1,449	1,543	1,174	1,641	1,794	1,147
May	2,343	3,507	2,428	1,928	1,829	1,266
Jun	2,551	4,336	2,019	1,966	1,945	1,374
Jul	2,421	3,783	2,096	2,012	1,987	1,389
Aug	1,892	2,700	1,892	1,644	1,608	1,110
Sep	916	1,378	969	772	688	473

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	589	543
Nov	344	385	358	341	321	289
Dec	494	693	701	311	327	274
Jan	729	1,448	752	354	306	279
Feb	976	2,009	1,123	335	381	282
Mar	915	1,644	604	584	677	593
Apr	1,542	1,634	1,504	1,702	1,756	1,140
May	2,259	3,441	2,182	1,821	1,835	1,263
Jun	2,558	4,347	2,032	1,966	1,945	1,380
Jul	2,421	3,781	2,092	2,012	1,987	1,396
Aug	1,885	2,683	1,895	1,644	1,608	1,100
Sep	909	1,360	953	772	688	478

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	579	590	619	537	606	537
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	725	1,433	752	354	306	279
Feb	981	1,999	1,164	335	381	282
Mar	917	1,659	604	584	677	585
Apr	1,449	1,543	1,174	1,641	1,794	1,147
May	2,343	3,507	2,428	1,928	1,829	1,266
Jun	2,551	4,336	2,019	1,966	1,945	1,374
Jul	2,421	3,783	2,096	2,012	1,987	1,389
Aug	1,892	2,700	1,892	1,644	1,608	1,110
Sep	916	1,378	969	772	688	473

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	589	543
Nov	344	385	358	341	321	289
Dec	494	693	701	311	327	274
Jan	729	1,448	752	354	306	279
Feb	976	2,009	1,123	335	381	282
Mar	915	1,644	604	584	677	593
Apr	1,542	1,634	1,504	1,702	1,756	1,140
May	2,259	3,441	2,182	1,821	1,835	1,263
Jun	2,558	4,347	2,032	1,966	1,945	1,380
Jul	2,421	3,781	2,092	2,012	1,987	1,396
Aug	1,885	2,683	1,895	1,644	1,608	1,100
Sep	909	1,360	953	772	688	478

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	579	590	619	537	606	537
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	725	1,433	752	354	306	279
Feb	981	1,999	1,164	335	381	282
Mar	917	1,659	604	584	677	585
Apr	1,449	1,543	1,174	1,641	1,794	1,147
May	2,343	3,507	2,428	1,928	1,829	1,266
Jun	2,551	4,336	2,019	1,966	1,945	1,374
Jul	2,421	3,783	2,096	2,012	1,987	1,389
Aug	1,892	2,700	1,892	1,644	1,608	1,110
Sep	916	1,378	969	772	688	473

RPA Scenario 5

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	454	484	483	378	494	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	593	783	814	420	431	357	590	783	800	420	431	357
Jan	896	1,673	958	499	435	363	891	1,658	958	499	435	363
Feb	1,158	2,294	1,344	497	473	360	1,163	2,284	1,385	497	473	360
Mar	832	1,844	609	389	343	295	837	1,859	609	389	343	295
Apr	747	1,134	681	690	603	393	654	1,042	352	629	641	402
May	890	1,999	720	405	374	208	975	2,065	965	513	368	217
Jun	927	2,619	307	280	184	141	922	2,608	294	280	184	141
Jul	703	2,004	257	172	126	97	703	2,006	261	172	126	95
Aug	473	1,180	377	128	115	81	478	1,197	374	128	115	80
Sep	271	650	245	76	63	54	279	668	261	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	454	484	483	378	494	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	593	783	814	420	431	357	590	783	800	420	431	357
Jan	896	1,673	958	499	435	363	891	1,658	958	499	435	363
Feb	1,158	2,294	1,344	497	473	360	1,163	2,284	1,385	497	473	360
Mar	832	1,844	609	389	343	295	837	1,859	609	389	343	295
Apr	747	1,134	681	690	603	393	654	1,042	352	629	641	402
May	890	1,999	720	405	374	208	975	2,065	965	513	368	217
Jun	927	2,619	307	280	184	141	922	2,608	294	280	184	141
Jul	703	2,004	257	172	126	97	703	2,006	261	172	126	95
Aug	473	1,180	377	128	115	81	478	1,197	374	128	115	80
Sep	271	650	245	76	63	54	279	668	261	76	63	54

RPA Scenario 6

Merced River Immediately Downstream from McClure

Steelhead and Chinook Salmon Spawning (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	587	540
Nov	344	385	358	341	321	289
Dec	494	693	699	311	327	274
Jan	728	1,444	752	354	306	279
Feb	974	2,005	1,124	335	381	282
Mar	920	1,655	604	584	677	605
Apr	1,552	1,641	1,504	1,701	1,828	1,119
May	2,260	3,454	2,157	1,792	1,872	1,267
Jun	2,547	4,321	2,016	1,966	1,945	1,378
Jul	2,423	3,780	2,107	2,012	1,987	1,394
Aug	1,886	2,688	1,894	1,644	1,608	1,099
Sep	909	1,360	953	772	688	477

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	581	590	619	537	606	544
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	726	1,435	752	354	306	279
Feb	982	2,005	1,161	335	381	282
Mar	919	1,659	604	584	677	593
Apr	1,453	1,542	1,175	1,667	1,812	1,129
May	2,332	3,501	2,378	1,885	1,875	1,266
Jun	2,553	4,338	2,022	1,966	1,945	1,377
Jul	2,425	3,787	2,109	2,012	1,987	1,391
Aug	1,892	2,700	1,895	1,644	1,608	1,112
Sep	919	1,378	972	772	688	484

Steelhead and Chinook Salmon Incubation and Fry Rearing (Target Flow = 400 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	587	540
Nov	344	385	358	341	321	289
Dec	494	693	699	311	327	274
Jan	728	1,444	752	354	306	279
Feb	974	2,005	1,124	335	381	282
Mar	920	1,655	604	584	677	605
Apr	1,552	1,641	1,504	1,701	1,828	1,119
May	2,260	3,454	2,157	1,792	1,872	1,267
Jun	2,547	4,321	2,016	1,966	1,945	1,378
Jul	2,423	3,780	2,107	2,012	1,987	1,394
Aug	1,886	2,688	1,894	1,644	1,608	1,099
Sep	909	1,360	953	772	688	477

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	581	590	619	537	606	544
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	726	1,435	752	354	306	279
Feb	982	2,005	1,161	335	381	282
Mar	919	1,659	604	584	677	593
Apr	1,453	1,542	1,175	1,667	1,812	1,129
May	2,332	3,501	2,378	1,885	1,875	1,266
Jun	2,553	4,338	2,022	1,966	1,945	1,377
Jul	2,425	3,787	2,109	2,012	1,987	1,391
Aug	1,892	2,700	1,895	1,644	1,608	1,112
Sep	919	1,378	972	772	688	484

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	587	540
Nov	344	385	358	341	321	289
Dec	494	693	699	311	327	274
Jan	728	1,444	752	354	306	279
Feb	974	2,005	1,124	335	381	282
Mar	920	1,655	604	584	677	605
Apr	1,552	1,641	1,504	1,701	1,828	1,119
May	2,260	3,454	2,157	1,792	1,872	1,267
Jun	2,547	4,321	2,016	1,966	1,945	1,378
Jul	2,423	3,780	2,107	2,012	1,987	1,394
Aug	1,886	2,688	1,894	1,644	1,608	1,099
Sep	909	1,360	953	772	688	477

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	581	590	619	537	606	544
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	726	1,435	752	354	306	279
Feb	982	2,005	1,161	335	381	282
Mar	919	1,659	604	584	677	593
Apr	1,453	1,542	1,175	1,667	1,812	1,129
May	2,332	3,501	2,378	1,885	1,875	1,266
Jun	2,553	4,338	2,022	1,966	1,945	1,377
Jul	2,425	3,787	2,109	2,012	1,987	1,391
Aug	1,892	2,700	1,895	1,644	1,608	1,112
Sep	919	1,378	972	772	688	484

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	577	589	618	537	587	540
Nov	344	385	358	341	321	289
Dec	494	693	699	311	327	274
Jan	728	1,444	752	354	306	279
Feb	974	2,005	1,124	335	381	282
Mar	920	1,655	604	584	677	605
Apr	1,552	1,641	1,504	1,701	1,828	1,119
May	2,260	3,454	2,157	1,792	1,872	1,267
Jun	2,547	4,321	2,016	1,966	1,945	1,378
Jul	2,423	3,780	2,107	2,012	1,987	1,394
Aug	1,886	2,688	1,894	1,644	1,608	1,099
Sep	909	1,360	953	772	688	477

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	581	590	619	537	606	544
Nov	344	385	358	341	321	289
Dec	491	693	687	311	327	274
Jan	726	1,435	752	354	306	279
Feb	982	2,005	1,161	335	381	282
Mar	919	1,659	604	584	677	593
Apr	1,453	1,542	1,175	1,667	1,812	1,129
May	2,332	3,501	2,378	1,885	1,875	1,266
Jun	2,553	4,338	2,022	1,966	1,945	1,377
Jul	2,425	3,787	2,109	2,012	1,987	1,391
Aug	1,892	2,700	1,895	1,644	1,608	1,112
Sep	919	1,378	972	772	688	484

RPA Scenario 6

Merced River Upstream from the San Joaquin River

Steelhead and Chinook Salmon Juvenile Rearing and Migration (Target Flow = 1,500 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	492	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	592	783	812	420	431	357	590	783	800	420	431	357
Jan	894	1,669	958	499	435	363	892	1,660	958	499	435	363
Feb	1,157	2,290	1,344	497	473	360	1,164	2,290	1,382	497	473	360
Mar	836	1,855	609	389	343	295	837	1,859	609	389	343	295
Apr	757	1,141	682	689	675	376	653	1,042	354	655	659	360
May	891	2,012	695	377	411	214	963	2,059	916	470	414	216
Jun	917	2,593	291	280	184	141	923	2,610	297	280	184	141
Jul	705	2,003	272	172	126	97	707	2,010	273	172	126	95
Aug	475	1,186	376	128	115	80	478	1,197	377	128	115	80
Sep	271	650	245	76	63	54	280	668	264	76	63	54

Steelhead and Chinook Salmon Juvenile Rearing and Steelhead Adult Migration (Target Flow = 250 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	453	484	483	378	492	408	457	484	483	378	511	408
Nov	437	479	497	429	407	348	437	479	497	429	407	348
Dec	592	783	812	420	431	357	590	783	800	420	431	357
Jan	894	1,669	958	499	435	363	892	1,660	958	499	435	363
Feb	1,157	2,290	1,344	497	473	360	1,164	2,290	1,382	497	473	360
Mar	836	1,855	609	389	343	295	837	1,859	609	389	343	295
Apr	757	1,141	682	689	675	376	653	1,042	354	655	659	360
May	891	2,012	695	377	411	214	963	2,059	916	470	414	216
Jun	917	2,593	291	280	184	141	923	2,610	297	280	184	141
Jul	705	2,003	272	172	126	97	707	2,010	273	172	126	95
Aug	475	1,186	376	128	115	80	478	1,197	377	128	115	80
Sep	271	650	245	76	63	54	280	668	264	76	63	54

Attachment 5

Flow Requirement Tables for Steelhead in the Tuolumne River

Appendix B

SAN JOAQUIN RIVER RESTORATION PROGRAM

November 2011

No RPA Scenario

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,004	1,029	925	1,010	1,157	918	1,006	1,032	928	1,009	1,160	917
Nov	405	414	568	334	371	311	407	419	569	335	376	311
Dec	719	884	1,291	490	402	345	724	884	1,316	490	402	345
Jan	1,241	2,210	1,617	581	566	495	1,239	2,204	1,617	581	566	495
Feb	1,705	3,346	2,020	750	649	563	1,714	3,371	2,029	750	649	563
Mar	2,503	4,498	2,473	1,352	1,477	1,307	2,506	4,502	2,482	1,369	1,463	1,307
Apr	3,346	4,487	3,302	3,211	2,960	2,101	3,300	4,451	3,176	3,149	2,947	2,104
May	3,687	5,339	3,825	3,273	3,008	1,961	3,688	5,318	3,799	3,332	3,026	1,958
Jun	3,362	5,920	2,779	2,440	2,429	1,614	3,375	5,944	2,815	2,436	2,429	1,614
Jul	3,409	5,335	3,071	2,784	2,773	1,880	3,411	5,337	3,084	2,780	2,776	1,880
Aug	2,425	2,812	2,682	2,397	2,396	1,632	2,430	2,822	2,695	2,397	2,395	1,632
Sep	1,464	1,789	1,671	1,436	1,343	890	1,469	1,797	1,679	1,445	1,342	890

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,004	1,029	925	1,010	1,157	918	1,006	1,032	928	1,009	1,160	917
Nov	405	414	568	334	371	311	407	419	569	335	376	311
Dec	719	884	1,291	490	402	345	724	884	1,316	490	402	345
Jan	1,241	2,210	1,617	581	566	495	1,239	2,204	1,617	581	566	495
Feb	1,705	3,346	2,020	750	649	563	1,714	3,371	2,029	750	649	563
Mar	2,503	4,498	2,473	1,352	1,477	1,307	2,506	4,502	2,482	1,369	1,463	1,307
Apr	3,346	4,487	3,302	3,211	2,960	2,101	3,300	4,451	3,176	3,149	2,947	2,104
May	3,687	5,339	3,825	3,273	3,008	1,961	3,688	5,318	3,799	3,332	3,026	1,958
Jun	3,362	5,920	2,779	2,440	2,429	1,614	3,375	5,944	2,815	2,436	2,429	1,614
Jul	3,409	5,335	3,071	2,784	2,773	1,880	3,411	5,337	3,084	2,780	2,776	1,880
Aug	2,425	2,812	2,682	2,397	2,396	1,632	2,430	2,822	2,695	2,397	2,395	1,632
Sep	1,464	1,789	1,671	1,436	1,343	890	1,469	1,797	1,679	1,445	1,342	890

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	575	596	797	459	528	453
Dec	830	1,049	1,419	585	500	378	835	1,049	1,445	585	500	378
Jan	1,265	2,396	1,620	548	547	381	1,264	2,390	1,620	548	547	381
Feb	1,688	3,437	2,069	696	543	419	1,697	3,461	2,078	696	543	419
Mar	2,119	4,509	2,376	830	757	430	2,122	4,513	2,384	846	743	430
Apr	2,036	3,782	2,211	1,520	952	543	1,983	3,740	2,060	1,457	944	543
May	1,859	3,510	1,798	1,398	930	574	1,859	3,483	1,768	1,464	954	570
Jun	1,430	3,866	655	413	348	257	1,441	3,888	676	413	348	257
Jul	1,103	2,857	549	374	329	247	1,103	2,857	549	374	329	247
Aug	476	699	548	371	343	261	476	702	548	371	343	261
Sep	482	727	548	360	344	261	483	729	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	575	596	797	459	528	453
Dec	830	1,049	1,419	585	500	378	835	1,049	1,445	585	500	378
Jan	1,265	2,396	1,620	548	547	381	1,264	2,390	1,620	548	547	381
Feb	1,688	3,437	2,069	696	543	419	1,697	3,461	2,078	696	543	419
Mar	2,119	4,509	2,376	830	757	430	2,122	4,513	2,384	846	743	430
Apr	2,036	3,782	2,211	1,520	952	543	1,983	3,740	2,060	1,457	944	543
May	1,859	3,510	1,798	1,398	930	574	1,859	3,483	1,768	1,464	954	570
Jun	1,430	3,866	655	413	348	257	1,441	3,888	676	413	348	257
Jul	1,103	2,857	549	374	329	247	1,103	2,857	549	374	329	247
Aug	476	699	548	371	343	261	476	702	548	371	343	261
Sep	482	727	548	360	344	261	483	729	548	360	344	261

RPA Scenario 1

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261
Sep	482	727	548	360	344	261

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261
Sep	482	727	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261
Sep	482	727	548	360	344	261

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261
Sep	482	727	548	360	344	261

RPA Scenario 2

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890	1,475	1,795	1,683	1,458	1,365	890

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890	1,475	1,795	1,683	1,458	1,365	890

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

RPA Scenario 3

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315
Dec	721	884	1,301	490	402	345
Jan	1,241	2,211	1,617	581	566	495
Feb	1,702	3,334	2,021	750	649	566
Mar	2,500	4,503	2,471	1,336	1,463	1,312
Apr	3,308	4,471	3,247	3,125	2,899	2,103
May	3,658	5,318	3,789	3,219	2,951	1,970
Jun	3,382	5,934	2,824	2,463	2,453	1,613
Jul	3,422	5,339	3,100	2,807	2,794	1,879
Aug	2,438	2,821	2,704	2,420	2,413	1,631
Sep	1,473	1,793	1,683	1,458	1,359	889

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315
Dec	726	884	1,326	490	402	344
Jan	1,238	2,201	1,617	581	566	495
Feb	1,715	3,372	2,029	750	649	566
Mar	2,505	4,500	2,478	1,364	1,463	1,311
Apr	3,283	4,451	3,178	3,099	2,897	2,102
May	3,659	5,306	3,756	3,276	2,957	1,974
Jun	3,389	5,946	2,842	2,463	2,452	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,878
Aug	2,438	2,822	2,704	2,420	2,412	1,630
Sep	1,474	1,795	1,683	1,458	1,359	889

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315
Dec	721	884	1,301	490	402	345
Jan	1,241	2,211	1,617	581	566	495
Feb	1,702	3,334	2,021	750	649	566
Mar	2,500	4,503	2,471	1,336	1,463	1,312
Apr	3,308	4,471	3,247	3,125	2,899	2,103
May	3,658	5,318	3,789	3,219	2,951	1,970
Jun	3,382	5,934	2,824	2,463	2,453	1,613
Jul	3,422	5,339	3,100	2,807	2,794	1,879
Aug	2,438	2,821	2,704	2,420	2,413	1,631
Sep	1,473	1,793	1,683	1,458	1,359	889

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315
Dec	726	884	1,326	490	402	344
Jan	1,238	2,201	1,617	581	566	495
Feb	1,715	3,372	2,029	750	649	566
Mar	2,505	4,500	2,478	1,364	1,463	1,311
Apr	3,283	4,451	3,178	3,099	2,897	2,102
May	3,659	5,306	3,756	3,276	2,957	1,974
Jun	3,389	5,946	2,842	2,463	2,452	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,878
Aug	2,438	2,822	2,704	2,420	2,412	1,630
Sep	1,474	1,795	1,683	1,458	1,359	889

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	832	1,049	1,429	585	500	378
Jan	1,266	2,398	1,620	548	547	381
Feb	1,684	3,425	2,070	696	543	419
Mar	2,114	4,513	2,373	813	742	430
Apr	1,983	3,759	2,128	1,411	867	543
May	1,814	3,479	1,733	1,321	847	583
Jun	1,436	3,876	672	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261
Sep	482	725	548	360	344	261

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	837	1,049	1,454	585	500	378
Jan	1,263	2,387	1,620	548	547	381
Feb	1,697	3,462	2,078	696	543	419
Mar	2,120	4,510	2,380	842	742	430
Apr	1,959	3,740	2,059	1,384	866	543
May	1,815	3,467	1,701	1,378	854	588
Jun	1,444	3,888	690	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	476	700	548	371	343	261
Sep	482	727	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	832	1,049	1,429	585	500	378
Jan	1,266	2,398	1,620	548	547	381
Feb	1,684	3,425	2,070	696	543	419
Mar	2,114	4,513	2,373	813	742	430
Apr	1,983	3,759	2,128	1,411	867	543
May	1,814	3,479	1,733	1,321	847	583
Jun	1,436	3,876	672	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261
Sep	482	725	548	360	344	261

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494
Nov	574	591	797	458	528	453
Dec	837	1,049	1,454	585	500	378
Jan	1,263	2,387	1,620	548	547	381
Feb	1,697	3,462	2,078	696	543	419
Mar	2,120	4,510	2,380	842	742	430
Apr	1,959	3,740	2,059	1,384	866	543
May	1,815	3,467	1,701	1,378	854	588
Jun	1,444	3,888	690	413	348	257
Jul	1,103	2,856	549	374	329	247
Aug	476	700	548	371	343	261
Sep	482	727	548	360	344	261

RPA Scenario 4

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,036	934	1,013	1,160	930	1,012	1,036	934	1,013	1,160	930
Nov	407	414	570	334	376	317	407	414	570	334	376	317
Dec	738	891	1,375	490	402	345	743	891	1,402	490	402	345
Jan	1,262	2,284	1,617	581	566	495	1,263	2,284	1,617	581	566	495
Feb	1,719	3,363	2,035	781	649	566	1,717	3,373	2,039	750	649	566
Mar	2,521	4,513	2,497	1,419	1,463	1,314	2,523	4,518	2,499	1,415	1,463	1,314
Apr	3,312	4,469	3,240	3,140	2,912	2,113	3,289	4,451	3,184	3,102	2,909	2,113
May	3,606	5,332	3,742	3,092	2,910	1,866	3,603	5,307	3,709	3,165	2,918	1,852
Jun	3,323	5,935	2,785	2,349	2,347	1,528	3,344	5,975	2,823	2,356	2,363	1,517
Jul	3,428	5,339	3,112	2,807	2,806	1,888	3,428	5,339	3,112	2,807	2,806	1,888
Aug	2,441	2,822	2,704	2,420	2,422	1,638	2,442	2,827	2,704	2,420	2,422	1,638
Sep	1,476	1,795	1,683	1,458	1,365	894	1,476	1,795	1,683	1,458	1,365	894

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,036	934	1,013	1,160	930	1,012	1,036	934	1,013	1,160	930
Nov	407	414	570	334	376	317	407	414	570	334	376	317
Dec	738	891	1,375	490	402	345	743	891	1,402	490	402	345
Jan	1,262	2,284	1,617	581	566	495	1,263	2,284	1,617	581	566	495
Feb	1,719	3,363	2,035	781	649	566	1,717	3,373	2,039	750	649	566
Mar	2,521	4,513	2,497	1,419	1,463	1,314	2,523	4,518	2,499	1,415	1,463	1,314
Apr	3,312	4,469	3,240	3,140	2,912	2,113	3,289	4,451	3,184	3,102	2,909	2,113
May	3,606	5,332	3,742	3,092	2,910	1,866	3,603	5,307	3,709	3,165	2,918	1,852
Jun	3,323	5,935	2,785	2,349	2,347	1,528	3,344	5,975	2,823	2,356	2,363	1,517
Jul	3,428	5,339	3,112	2,807	2,806	1,888	3,428	5,339	3,112	2,807	2,806	1,888
Aug	2,441	2,822	2,704	2,420	2,422	1,638	2,442	2,827	2,704	2,420	2,422	1,638
Sep	1,476	1,795	1,683	1,458	1,365	894	1,476	1,795	1,683	1,458	1,365	894

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	848	1,056	1,503	585	500	378	853	1,056	1,530	585	500	378
Jan	1,287	2,470	1,620	548	547	381	1,287	2,470	1,620	548	547	381
Feb	1,700	3,453	2,084	727	543	419	1,699	3,463	2,088	696	543	419
Mar	2,136	4,523	2,400	897	742	430	2,137	4,527	2,402	893	742	430
Apr	1,916	3,754	2,062	1,306	758	452	1,898	3,736	2,011	1,286	769	441
May	1,758	3,487	1,689	1,201	795	470	1,754	3,462	1,664	1,262	804	455
Jun	1,443	3,886	691	413	348	257	1,460	3,927	715	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	476	700	548	371	343	261	477	705	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	848	1,056	1,503	585	500	378	853	1,056	1,530	585	500	378
Jan	1,287	2,470	1,620	548	547	381	1,287	2,470	1,620	548	547	381
Feb	1,700	3,453	2,084	727	543	419	1,699	3,463	2,088	696	543	419
Mar	2,136	4,523	2,400	897	742	430	2,137	4,527	2,402	893	742	430
Apr	1,916	3,754	2,062	1,306	758	452	1,898	3,736	2,011	1,286	769	441
May	1,758	3,487	1,689	1,201	795	470	1,754	3,462	1,664	1,262	804	455
Jun	1,443	3,886	691	413	348	257	1,460	3,927	715	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	476	700	548	371	343	261	477	705	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

RPA Scenario 5

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	720	884	1,294	490	402	345	723	884	1,311	490	402	344
Jan	1,238	2,199	1,617	581	566	495	1,234	2,188	1,617	581	566	495
Feb	1,701	3,329	2,021	750	649	566	1,713	3,364	2,029	750	649	566
Mar	2,500	4,498	2,475	1,341	1,463	1,311	2,502	4,504	2,479	1,340	1,463	1,311
Apr	3,309	4,471	3,264	3,133	2,881	2,103	3,287	4,451	3,178	3,105	2,914	2,102
May	3,667	5,323	3,766	3,239	2,985	1,987	3,668	5,312	3,771	3,266	2,977	1,986
Jun	3,381	5,933	2,824	2,463	2,452	1,613	3,388	5,943	2,842	2,463	2,451	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,879	3,422	5,339	3,100	2,807	2,792	1,878
Aug	2,438	2,821	2,704	2,420	2,412	1,631	2,437	2,821	2,704	2,420	2,411	1,630
Sep	1,472	1,790	1,683	1,458	1,359	889	1,473	1,793	1,683	1,458	1,358	889

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	720	884	1,294	490	402	345	723	884	1,311	490	402	344
Jan	1,238	2,199	1,617	581	566	495	1,234	2,188	1,617	581	566	495
Feb	1,701	3,329	2,021	750	649	566	1,713	3,364	2,029	750	649	566
Mar	2,500	4,498	2,475	1,341	1,463	1,311	2,502	4,504	2,479	1,340	1,463	1,311
Apr	3,309	4,471	3,264	3,133	2,881	2,103	3,287	4,451	3,178	3,105	2,914	2,102
May	3,667	5,323	3,766	3,239	2,985	1,987	3,668	5,312	3,771	3,266	2,977	1,986
Jun	3,381	5,933	2,824	2,463	2,452	1,613	3,388	5,943	2,842	2,463	2,451	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,879	3,422	5,339	3,100	2,807	2,792	1,878
Aug	2,438	2,821	2,704	2,420	2,412	1,631	2,437	2,821	2,704	2,420	2,411	1,630
Sep	1,472	1,790	1,683	1,458	1,359	889	1,473	1,793	1,683	1,458	1,358	889

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	830	1,049	1,422	585	500	378	834	1,049	1,439	585	500	378
Jan	1,262	2,385	1,620	548	547	381	1,259	2,374	1,620	548	547	381
Feb	1,683	3,420	2,070	696	543	419	1,695	3,455	2,078	696	543	419
Mar	2,115	4,508	2,378	819	742	430	2,117	4,513	2,381	818	742	430
Apr	1,985	3,759	2,145	1,419	850	543	1,963	3,740	2,059	1,390	884	543
May	1,823	3,484	1,710	1,342	882	600	1,824	3,473	1,716	1,368	875	600
Jun	1,436	3,874	672	413	348	257	1,443	3,885	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	699	548	371	343	261
Sep	481	722	548	360	344	261	482	725	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	830	1,049	1,422	585	500	378	834	1,049	1,439	585	500	378
Jan	1,262	2,385	1,620	548	547	381	1,259	2,374	1,620	548	547	381
Feb	1,683	3,420	2,070	696	543	419	1,695	3,455	2,078	696	543	419
Mar	2,115	4,508	2,378	819	742	430	2,117	4,513	2,381	818	742	430
Apr	1,985	3,759	2,145	1,419	850	543	1,963	3,740	2,059	1,390	884	543
May	1,823	3,484	1,710	1,342	882	600	1,824	3,473	1,716	1,368	875	600
Jun	1,436	3,874	672	413	348	257	1,443	3,885	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	699	548	371	343	261
Sep	481	722	548	360	344	261	482	725	548	360	344	261

RPA Scenario 6

Tuolumne River Downstream from Don Pedro Reservoir

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	1,011	1,037	934	1,013	1,160	927	1,011	1,037	934	1,013	1,160	926
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	731	896	1,335	490	402	345	739	891	1,383	490	402	345
Jan	1,263	2,286	1,617	581	566	495	1,262	2,281	1,617	581	566	495
Feb	1,718	3,360	2,020	801	649	566	1,735	3,403	2,029	817	649	566
Mar	2,523	4,532	2,479	1,419	1,463	1,313	2,522	4,516	2,495	1,421	1,463	1,312
Apr	3,309	4,469	3,243	3,127	2,907	2,110	3,287	4,451	3,184	3,102	2,901	2,110
May	3,614	5,320	3,746	3,123	2,876	1,920	3,604	5,296	3,702	3,185	2,863	1,913
Jun	3,330	5,931	2,802	2,374	2,313	1,560	3,337	5,956	2,801	2,374	2,312	1,560
Jul	3,427	5,339	3,112	2,807	2,801	1,885	3,426	5,339	3,112	2,807	2,797	1,885
Aug	2,443	2,835	2,704	2,420	2,418	1,635	2,444	2,839	2,704	2,420	2,415	1,636
Sep	1,475	1,795	1,683	1,458	1,362	892	1,475	1,795	1,683	1,458	1,361	892

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	1,011	1,037	934	1,013	1,160	927	1,011	1,037	934	1,013	1,160	926
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	731	896	1,335	490	402	345	739	891	1,383	490	402	345
Jan	1,263	2,286	1,617	581	566	495	1,262	2,281	1,617	581	566	495
Feb	1,718	3,360	2,020	801	649	566	1,735	3,403	2,029	817	649	566
Mar	2,523	4,532	2,479	1,419	1,463	1,313	2,522	4,516	2,495	1,421	1,463	1,312
Apr	3,309	4,469	3,243	3,127	2,907	2,110	3,287	4,451	3,184	3,102	2,901	2,110
May	3,614	5,320	3,746	3,123	2,876	1,920	3,604	5,296	3,702	3,185	2,863	1,913
Jun	3,330	5,931	2,802	2,374	2,313	1,560	3,337	5,956	2,801	2,374	2,312	1,560
Jul	3,427	5,339	3,112	2,807	2,801	1,885	3,426	5,339	3,112	2,807	2,797	1,885
Aug	2,443	2,835	2,704	2,420	2,418	1,635	2,444	2,839	2,704	2,420	2,415	1,636
Sep	1,475	1,795	1,683	1,458	1,362	892	1,475	1,795	1,683	1,458	1,361	892

Tuolumne River Upstream from the San Joaquin River

Steelhead All Life Stages (Target Flow = 275 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	842	1,061	1,463	585	500	378	850	1,056	1,512	585	500	378
Jan	1,288	2,472	1,620	548	547	381	1,286	2,467	1,620	548	547	381
Feb	1,700	3,450	2,069	747	543	419	1,717	3,494	2,078	763	543	419
Mar	2,138	4,542	2,382	897	742	430	2,136	4,525	2,398	898	742	430
Apr	1,915	3,740	2,055	1,319	727	486	1,894	3,723	1,992	1,299	726	486
May	1,769	3,480	1,697	1,229	765	527	1,761	3,457	1,660	1,285	755	520
Jun	1,449	3,890	714	413	348	257	1,455	3,914	710	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	480	713	548	371	343	261	481	717	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Steelhead Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	842	1,061	1,463	585	500	378	850	1,056	1,512	585	500	378
Jan	1,288	2,472	1,620	548	547	381	1,286	2,467	1,620	548	547	381
Feb	1,700	3,450	2,069	747	543	419	1,717	3,494	2,078	763	543	419
Mar	2,138	4,542	2,382	897	742	430	2,136	4,525	2,398	898	742	430
Apr	1,915	3,740	2,055	1,319	727	486	1,894	3,723	1,992	1,299	726	486
May	1,769	3,480	1,697	1,229	765	527	1,761	3,457	1,660	1,285	755	520
Jun	1,449	3,890	714	413	348	257	1,455	3,914	710	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	480	713	548	371	343	261	481	717	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Attachment 6

Flow Requirement Tables for Chinook Salmon in the Tuolumne River

Appendix B

SAN JOAQUIN RIVER RESTORATION PROGRAM

November 2011

No RPA Scenario

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,004	1,029	925	1,010	1,157	918	1,006	1,032	928	1,009	1,160	917
Nov	405	414	568	334	371	311	407	419	569	335	376	311
Dec	719	884	1,291	490	402	345	724	884	1,316	490	402	345
Jan	1,241	2,210	1,617	581	566	495	1,239	2,204	1,617	581	566	495
Feb	1,705	3,346	2,020	750	649	563	1,714	3,371	2,029	750	649	563
Mar	2,503	4,498	2,473	1,352	1,477	1,307	2,506	4,502	2,482	1,369	1,463	1,307
Apr	3,346	4,487	3,302	3,211	2,960	2,101	3,300	4,451	3,176	3,149	2,947	2,104
May	3,687	5,339	3,825	3,273	3,008	1,961	3,688	5,318	3,799	3,332	3,026	1,958
Jun	3,362	5,920	2,779	2,440	2,429	1,614	3,375	5,944	2,815	2,436	2,429	1,614
Jul	3,409	5,335	3,071	2,784	2,773	1,880	3,411	5,337	3,084	2,780	2,776	1,880
Aug	2,425	2,812	2,682	2,397	2,396	1,632	2,430	2,822	2,695	2,397	2,395	1,632
Sep	1,464	1,789	1,671	1,436	1,343	890	1,469	1,797	1,679	1,445	1,342	890

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,004	1,029	925	1,010	1,157	918	1,006	1,032	928	1,009	1,160	917
Nov	405	414	568	334	371	311	407	419	569	335	376	311
Dec	719	884	1,291	490	402	345	724	884	1,316	490	402	345
Jan	1,241	2,210	1,617	581	566	495	1,239	2,204	1,617	581	566	495
Feb	1,705	3,346	2,020	750	649	563	1,714	3,371	2,029	750	649	563
Mar	2,503	4,498	2,473	1,352	1,477	1,307	2,506	4,502	2,482	1,369	1,463	1,307
Apr	3,346	4,487	3,302	3,211	2,960	2,101	3,300	4,451	3,176	3,149	2,947	2,104
May	3,687	5,339	3,825	3,273	3,008	1,961	3,688	5,318	3,799	3,332	3,026	1,958
Jun	3,362	5,920	2,779	2,440	2,429	1,614	3,375	5,944	2,815	2,436	2,429	1,614
Jul	3,409	5,335	3,071	2,784	2,773	1,880	3,411	5,337	3,084	2,780	2,776	1,880
Aug	2,425	2,812	2,682	2,397	2,396	1,632	2,430	2,822	2,695	2,397	2,395	1,632
Sep	1,464	1,789	1,671	1,436	1,343	890	1,469	1,797	1,679	1,445	1,342	890

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,004	1,029	925	1,010	1,157	918	1,006	1,032	928	1,009	1,160	917
Nov	405	414	568	334	371	311	407	419	569	335	376	311
Dec	719	884	1,291	490	402	345	724	884	1,316	490	402	345
Jan	1,241	2,210	1,617	581	566	495	1,239	2,204	1,617	581	566	495
Feb	1,705	3,346	2,020	750	649	563	1,714	3,371	2,029	750	649	563
Mar	2,503	4,498	2,473	1,352	1,477	1,307	2,506	4,502	2,482	1,369	1,463	1,307
Apr	3,346	4,487	3,302	3,211	2,960	2,101	3,300	4,451	3,176	3,149	2,947	2,104
May	3,687	5,339	3,825	3,273	3,008	1,961	3,688	5,318	3,799	3,332	3,026	1,958
Jun	3,362	5,920	2,779	2,440	2,429	1,614	3,375	5,944	2,815	2,436	2,429	1,614
Jul	3,409	5,335	3,071	2,784	2,773	1,880	3,411	5,337	3,084	2,780	2,776	1,880
Aug	2,425	2,812	2,682	2,397	2,396	1,632	2,430	2,822	2,695	2,397	2,395	1,632
Sep	1,464	1,789	1,671	1,436	1,343	890	1,469	1,797	1,679	1,445	1,342	890

No RPA Scenario

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	575	596	797	459	528	453
Dec	830	1,049	1,419	585	500	378	835	1,049	1,445	585	500	378
Jan	1,265	2,396	1,620	548	547	381	1,264	2,390	1,620	548	547	381
Feb	1,688	3,437	2,069	696	543	419	1,697	3,461	2,078	696	543	419
Mar	2,119	4,509	2,376	830	757	430	2,122	4,513	2,384	846	743	430
Apr	2,036	3,782	2,211	1,520	952	543	1,983	3,740	2,060	1,457	944	543
May	1,859	3,510	1,798	1,398	930	574	1,859	3,483	1,768	1,464	954	570
Jun	1,430	3,866	655	413	348	257	1,441	3,888	676	413	348	257
Jul	1,103	2,857	549	374	329	247	1,103	2,857	549	374	329	247
Aug	476	699	548	371	343	261	476	702	548	371	343	261
Sep	482	727	548	360	344	261	483	729	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	575	596	797	459	528	453
Dec	830	1,049	1,419	585	500	378	835	1,049	1,445	585	500	378
Jan	1,265	2,396	1,620	548	547	381	1,264	2,390	1,620	548	547	381
Feb	1,688	3,437	2,069	696	543	419	1,697	3,461	2,078	696	543	419
Mar	2,119	4,509	2,376	830	757	430	2,122	4,513	2,384	846	743	430
Apr	2,036	3,782	2,211	1,520	952	543	1,983	3,740	2,060	1,457	944	543
May	1,859	3,510	1,798	1,398	930	574	1,859	3,483	1,768	1,464	954	570
Jun	1,430	3,866	655	413	348	257	1,441	3,888	676	413	348	257
Jul	1,103	2,857	549	374	329	247	1,103	2,857	549	374	329	247
Aug	476	699	548	371	343	261	476	702	548	371	343	261
Sep	482	727	548	360	344	261	483	729	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	575	596	797	459	528	453
Dec	830	1,049	1,419	585	500	378	835	1,049	1,445	585	500	378
Jan	1,265	2,396	1,620	548	547	381	1,264	2,390	1,620	548	547	381
Feb	1,688	3,437	2,069	696	543	419	1,697	3,461	2,078	696	543	419
Mar	2,119	4,509	2,376	830	757	430	2,122	4,513	2,384	846	743	430
Apr	2,036	3,782	2,211	1,520	952	543	1,983	3,740	2,060	1,457	944	543
May	1,859	3,510	1,798	1,398	930	574	1,859	3,483	1,768	1,464	954	570
Jun	1,430	3,866	655	413	348	257	1,441	3,888	676	413	348	257
Jul	1,103	2,857	549	374	329	247	1,103	2,857	549	374	329	247
Aug	476	699	548	371	343	261	476	702	548	371	343	261
Sep	482	727	548	360	344	261	483	729	548	360	344	261

RPA Scenario 1

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890	1,475	1,795	1,683	1,458	1,365	890

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890	1,475	1,795	1,683	1,458	1,365	890

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890	1,475	1,795	1,683	1,458	1,365	890

RPA Scenario 1

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

RPA Scenario 2

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,038	934	1,013	1,160	927
Nov	407	414	570	334	376	316
Dec	728	884	1,337	490	402	345
Jan	1,261	2,280	1,617	581	566	495
Feb	1,722	3,373	2,064	750	649	566
Mar	2,521	4,525	2,493	1,402	1,463	1,314
Apr	3,271	4,451	3,184	3,049	2,858	2,104
May	3,600	5,288	3,693	3,131	2,888	1,934
Jun	3,398	5,965	2,850	2,463	2,463	1,614
Jul	3,424	5,339	3,100	2,807	2,806	1,880
Aug	2,441	2,826	2,704	2,420	2,422	1,632
Sep	1,475	1,795	1,683	1,458	1,365	890

RPA Scenario 2

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	839	1,049	1,466	585	500	378	839	1,049	1,466	585	500	378
Jan	1,286	2,466	1,620	548	547	381	1,286	2,466	1,620	548	547	381
Feb	1,704	3,464	2,113	696	543	419	1,704	3,464	2,113	696	543	419
Mar	2,136	4,534	2,395	880	742	430	2,136	4,534	2,395	880	742	430
Apr	1,944	3,740	2,066	1,335	815	543	1,944	3,740	2,066	1,335	815	543
May	1,754	3,449	1,637	1,233	776	546	1,754	3,449	1,637	1,233	776	546
Jun	1,451	3,907	698	413	348	257	1,451	3,907	698	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	477	704	548	371	343	261	477	704	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

RPA Scenario 3

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	721	884	1,301	490	402	345	726	884	1,326	490	402	344
Jan	1,241	2,211	1,617	581	566	495	1,238	2,201	1,617	581	566	495
Feb	1,702	3,334	2,021	750	649	566	1,715	3,372	2,029	750	649	566
Mar	2,500	4,503	2,471	1,336	1,463	1,312	2,505	4,500	2,478	1,364	1,463	1,311
Apr	3,308	4,471	3,247	3,125	2,899	2,103	3,283	4,451	3,178	3,099	2,897	2,102
May	3,658	5,318	3,789	3,219	2,951	1,970	3,659	5,306	3,756	3,276	2,957	1,974
Jun	3,382	5,934	2,824	2,463	2,453	1,613	3,389	5,946	2,842	2,463	2,452	1,612
Jul	3,422	5,339	3,100	2,807	2,794	1,879	3,422	5,339	3,100	2,807	2,793	1,878
Aug	2,438	2,821	2,704	2,420	2,413	1,631	2,438	2,822	2,704	2,420	2,412	1,630
Sep	1,473	1,793	1,683	1,458	1,359	889	1,474	1,795	1,683	1,458	1,359	889

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	721	884	1,301	490	402	345	726	884	1,326	490	402	344
Jan	1,241	2,211	1,617	581	566	495	1,238	2,201	1,617	581	566	495
Feb	1,702	3,334	2,021	750	649	566	1,715	3,372	2,029	750	649	566
Mar	2,500	4,503	2,471	1,336	1,463	1,312	2,505	4,500	2,478	1,364	1,463	1,311
Apr	3,308	4,471	3,247	3,125	2,899	2,103	3,283	4,451	3,178	3,099	2,897	2,102
May	3,658	5,318	3,789	3,219	2,951	1,970	3,659	5,306	3,756	3,276	2,957	1,974
Jun	3,382	5,934	2,824	2,463	2,453	1,613	3,389	5,946	2,842	2,463	2,452	1,612
Jul	3,422	5,339	3,100	2,807	2,794	1,879	3,422	5,339	3,100	2,807	2,793	1,878
Aug	2,438	2,821	2,704	2,420	2,413	1,631	2,438	2,822	2,704	2,420	2,412	1,630
Sep	1,473	1,793	1,683	1,458	1,359	889	1,474	1,795	1,683	1,458	1,359	889

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	721	884	1,301	490	402	345	726	884	1,326	490	402	344
Jan	1,241	2,211	1,617	581	566	495	1,238	2,201	1,617	581	566	495
Feb	1,702	3,334	2,021	750	649	566	1,715	3,372	2,029	750	649	566
Mar	2,500	4,503	2,471	1,336	1,463	1,312	2,505	4,500	2,478	1,364	1,463	1,311
Apr	3,308	4,471	3,247	3,125	2,899	2,103	3,283	4,451	3,178	3,099	2,897	2,102
May	3,658	5,318	3,789	3,219	2,951	1,970	3,659	5,306	3,756	3,276	2,957	1,974
Jun	3,382	5,934	2,824	2,463	2,453	1,613	3,389	5,946	2,842	2,463	2,452	1,612
Jul	3,422	5,339	3,100	2,807	2,794	1,879	3,422	5,339	3,100	2,807	2,793	1,878
Aug	2,438	2,821	2,704	2,420	2,413	1,631	2,438	2,822	2,704	2,420	2,412	1,630
Sep	1,473	1,793	1,683	1,458	1,359	889	1,474	1,795	1,683	1,458	1,359	889

RPA Scenario 3

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	832	1,049	1,429	585	500	378	837	1,049	1,454	585	500	378
Jan	1,266	2,398	1,620	548	547	381	1,263	2,387	1,620	548	547	381
Feb	1,684	3,425	2,070	696	543	419	1,697	3,462	2,078	696	543	419
Mar	2,114	4,513	2,373	813	742	430	2,120	4,510	2,380	842	742	430
Apr	1,983	3,759	2,128	1,411	867	543	1,959	3,740	2,059	1,384	866	543
May	1,814	3,479	1,733	1,321	847	583	1,815	3,467	1,701	1,378	854	588
Jun	1,436	3,876	672	413	348	257	1,444	3,888	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	700	548	371	343	261
Sep	482	725	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	832	1,049	1,429	585	500	378	837	1,049	1,454	585	500	378
Jan	1,266	2,398	1,620	548	547	381	1,263	2,387	1,620	548	547	381
Feb	1,684	3,425	2,070	696	543	419	1,697	3,462	2,078	696	543	419
Mar	2,114	4,513	2,373	813	742	430	2,120	4,510	2,380	842	742	430
Apr	1,983	3,759	2,128	1,411	867	543	1,959	3,740	2,059	1,384	866	543
May	1,814	3,479	1,733	1,321	847	583	1,815	3,467	1,701	1,378	854	588
Jun	1,436	3,876	672	413	348	257	1,444	3,888	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	700	548	371	343	261
Sep	482	725	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	832	1,049	1,429	585	500	378	837	1,049	1,454	585	500	378
Jan	1,266	2,398	1,620	548	547	381	1,263	2,387	1,620	548	547	381
Feb	1,684	3,425	2,070	696	543	419	1,697	3,462	2,078	696	543	419
Mar	2,114	4,513	2,373	813	742	430	2,120	4,510	2,380	842	742	430
Apr	1,983	3,759	2,128	1,411	867	543	1,959	3,740	2,059	1,384	866	543
May	1,814	3,479	1,733	1,321	847	583	1,815	3,467	1,701	1,378	854	588
Jun	1,436	3,876	672	413	348	257	1,444	3,888	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	700	548	371	343	261
Sep	482	725	548	360	344	261	482	727	548	360	344	261

RPA Scenario 4

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,036	934	1,013	1,160	930	1,012	1,036	934	1,013	1,160	930
Nov	407	414	570	334	376	317	407	414	570	334	376	317
Dec	738	891	1,375	490	402	345	743	891	1,402	490	402	345
Jan	1,262	2,284	1,617	581	566	495	1,263	2,284	1,617	581	566	495
Feb	1,719	3,363	2,035	781	649	566	1,717	3,373	2,039	750	649	566
Mar	2,521	4,513	2,497	1,419	1,463	1,314	2,523	4,518	2,499	1,415	1,463	1,314
Apr	3,312	4,469	3,240	3,140	2,912	2,113	3,289	4,451	3,184	3,102	2,909	2,113
May	3,606	5,332	3,742	3,092	2,910	1,866	3,603	5,307	3,709	3,165	2,918	1,852
Jun	3,323	5,935	2,785	2,349	2,347	1,528	3,344	5,975	2,823	2,356	2,363	1,517
Jul	3,428	5,339	3,112	2,807	2,806	1,888	3,428	5,339	3,112	2,807	2,806	1,888
Aug	2,441	2,822	2,704	2,420	2,422	1,638	2,442	2,827	2,704	2,420	2,422	1,638
Sep	1,476	1,795	1,683	1,458	1,365	894	1,476	1,795	1,683	1,458	1,365	894

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,036	934	1,013	1,160	930	1,012	1,036	934	1,013	1,160	930
Nov	407	414	570	334	376	317	407	414	570	334	376	317
Dec	738	891	1,375	490	402	345	743	891	1,402	490	402	345
Jan	1,262	2,284	1,617	581	566	495	1,263	2,284	1,617	581	566	495
Feb	1,719	3,363	2,035	781	649	566	1,717	3,373	2,039	750	649	566
Mar	2,521	4,513	2,497	1,419	1,463	1,314	2,523	4,518	2,499	1,415	1,463	1,314
Apr	3,312	4,469	3,240	3,140	2,912	2,113	3,289	4,451	3,184	3,102	2,909	2,113
May	3,606	5,332	3,742	3,092	2,910	1,866	3,603	5,307	3,709	3,165	2,918	1,852
Jun	3,323	5,935	2,785	2,349	2,347	1,528	3,344	5,975	2,823	2,356	2,363	1,517
Jul	3,428	5,339	3,112	2,807	2,806	1,888	3,428	5,339	3,112	2,807	2,806	1,888
Aug	2,441	2,822	2,704	2,420	2,422	1,638	2,442	2,827	2,704	2,420	2,422	1,638
Sep	1,476	1,795	1,683	1,458	1,365	894	1,476	1,795	1,683	1,458	1,365	894

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,012	1,036	934	1,013	1,160	930	1,012	1,036	934	1,013	1,160	930
Nov	407	414	570	334	376	317	407	414	570	334	376	317
Dec	738	891	1,375	490	402	345	743	891	1,402	490	402	345
Jan	1,262	2,284	1,617	581	566	495	1,263	2,284	1,617	581	566	495
Feb	1,719	3,363	2,035	781	649	566	1,717	3,373	2,039	750	649	566
Mar	2,521	4,513	2,497	1,419	1,463	1,314	2,523	4,518	2,499	1,415	1,463	1,314
Apr	3,312	4,469	3,240	3,140	2,912	2,113	3,289	4,451	3,184	3,102	2,909	2,113
May	3,606	5,332	3,742	3,092	2,910	1,866	3,603	5,307	3,709	3,165	2,918	1,852
Jun	3,323	5,935	2,785	2,349	2,347	1,528	3,344	5,975	2,823	2,356	2,363	1,517
Jul	3,428	5,339	3,112	2,807	2,806	1,888	3,428	5,339	3,112	2,807	2,806	1,888
Aug	2,441	2,822	2,704	2,420	2,422	1,638	2,442	2,827	2,704	2,420	2,422	1,638
Sep	1,476	1,795	1,683	1,458	1,365	894	1,476	1,795	1,683	1,458	1,365	894

RPA Scenario 4

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	848	1,056	1,503	585	500	378	853	1,056	1,530	585	500	378
Jan	1,287	2,470	1,620	548	547	381	1,287	2,470	1,620	548	547	381
Feb	1,700	3,453	2,084	727	543	419	1,699	3,463	2,088	696	543	419
Mar	2,136	4,523	2,400	897	742	430	2,137	4,527	2,402	893	742	430
Apr	1,916	3,754	2,062	1,306	758	452	1,898	3,736	2,011	1,286	769	441
May	1,758	3,487	1,689	1,201	795	470	1,754	3,462	1,664	1,262	804	455
Jun	1,443	3,886	691	413	348	257	1,460	3,927	715	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	476	700	548	371	343	261	477	705	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	848	1,056	1,503	585	500	378	853	1,056	1,530	585	500	378
Jan	1,287	2,470	1,620	548	547	381	1,287	2,470	1,620	548	547	381
Feb	1,700	3,453	2,084	727	543	419	1,699	3,463	2,088	696	543	419
Mar	2,136	4,523	2,400	897	742	430	2,137	4,527	2,402	893	742	430
Apr	1,916	3,754	2,062	1,306	758	452	1,898	3,736	2,011	1,286	769	441
May	1,758	3,487	1,689	1,201	795	470	1,754	3,462	1,664	1,262	804	455
Jun	1,443	3,886	691	413	348	257	1,460	3,927	715	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	476	700	548	371	343	261	477	705	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition All	Baseline Wet	Baseline Above Normal	Baseline Below Normal	Baseline Dry	Baseline Critical	Proposed Action All	Proposed Wet	Proposed Above Normal	Proposed Below Normal	Proposed Dry	Proposed Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	848	1,056	1,503	585	500	378	853	1,056	1,530	585	500	378
Jan	1,287	2,470	1,620	548	547	381	1,287	2,470	1,620	548	547	381
Feb	1,700	3,453	2,084	727	543	419	1,699	3,463	2,088	696	543	419
Mar	2,136	4,523	2,400	897	742	430	2,137	4,527	2,402	893	742	430
Apr	1,916	3,754	2,062	1,306	758	452	1,898	3,736	2,011	1,286	769	441
May	1,758	3,487	1,689	1,201	795	470	1,754	3,462	1,664	1,262	804	455
Jun	1,443	3,886	691	413	348	257	1,460	3,927	715	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	476	700	548	371	343	261	477	705	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

RPA Scenario 5

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	720	884	1,294	490	402	345	723	884	1,311	490	402	344
Jan	1,238	2,199	1,617	581	566	495	1,234	2,188	1,617	581	566	495
Feb	1,701	3,329	2,021	750	649	566	1,713	3,364	2,029	750	649	566
Mar	2,500	4,498	2,475	1,341	1,463	1,311	2,502	4,504	2,479	1,340	1,463	1,311
Apr	3,309	4,471	3,264	3,133	2,881	2,103	3,287	4,451	3,178	3,105	2,914	2,102
May	3,667	5,323	3,766	3,239	2,985	1,987	3,668	5,312	3,771	3,266	2,977	1,986
Jun	3,381	5,933	2,824	2,463	2,452	1,613	3,388	5,943	2,842	2,463	2,451	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,879	3,422	5,339	3,100	2,807	2,792	1,878
Aug	2,438	2,821	2,704	2,420	2,412	1,631	2,437	2,821	2,704	2,420	2,411	1,630
Sep	1,472	1,790	1,683	1,458	1,359	889	1,473	1,793	1,683	1,458	1,358	889

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	720	884	1,294	490	402	345	723	884	1,311	490	402	344
Jan	1,238	2,199	1,617	581	566	495	1,234	2,188	1,617	581	566	495
Feb	1,701	3,329	2,021	750	649	566	1,713	3,364	2,029	750	649	566
Mar	2,500	4,498	2,475	1,341	1,463	1,311	2,502	4,504	2,479	1,340	1,463	1,311
Apr	3,309	4,471	3,264	3,133	2,881	2,103	3,287	4,451	3,178	3,105	2,914	2,102
May	3,667	5,323	3,766	3,239	2,985	1,987	3,668	5,312	3,771	3,266	2,977	1,986
Jun	3,381	5,933	2,824	2,463	2,452	1,613	3,388	5,943	2,842	2,463	2,451	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,879	3,422	5,339	3,100	2,807	2,792	1,878
Aug	2,438	2,821	2,704	2,420	2,412	1,631	2,437	2,821	2,704	2,420	2,411	1,630
Sep	1,472	1,790	1,683	1,458	1,359	889	1,473	1,793	1,683	1,458	1,358	889

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,038	934	1,013	1,160	924	1,011	1,038	934	1,013	1,160	924
Nov	406	414	570	334	376	315	406	414	570	334	376	315
Dec	720	884	1,294	490	402	345	723	884	1,311	490	402	344
Jan	1,238	2,199	1,617	581	566	495	1,234	2,188	1,617	581	566	495
Feb	1,701	3,329	2,021	750	649	566	1,713	3,364	2,029	750	649	566
Mar	2,500	4,498	2,475	1,341	1,463	1,311	2,502	4,504	2,479	1,340	1,463	1,311
Apr	3,309	4,471	3,264	3,133	2,881	2,103	3,287	4,451	3,178	3,105	2,914	2,102
May	3,667	5,323	3,766	3,239	2,985	1,987	3,668	5,312	3,771	3,266	2,977	1,986
Jun	3,381	5,933	2,824	2,463	2,452	1,613	3,388	5,943	2,842	2,463	2,451	1,612
Jul	3,422	5,339	3,100	2,807	2,793	1,879	3,422	5,339	3,100	2,807	2,792	1,878
Aug	2,438	2,821	2,704	2,420	2,412	1,631	2,437	2,821	2,704	2,420	2,411	1,630
Sep	1,472	1,790	1,683	1,458	1,359	889	1,473	1,793	1,683	1,458	1,358	889

RPA Scenario 5

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition All	Baseline Condition Wet	Baseline Condition Above Normal	Baseline Condition Below Normal	Baseline Condition Dry	Baseline Condition Critical	Proposed Action All	Proposed Action Wet	Proposed Action Above Normal	Proposed Action Below Normal	Proposed Action Dry	Proposed Action Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	830	1,049	1,422	585	500	378	834	1,049	1,439	585	500	378
Jan	1,262	2,385	1,620	548	547	381	1,259	2,374	1,620	548	547	381
Feb	1,683	3,420	2,070	696	543	419	1,695	3,455	2,078	696	543	419
Mar	2,115	4,508	2,378	819	742	430	2,117	4,513	2,381	818	742	430
Apr	1,985	3,759	2,145	1,419	850	543	1,963	3,740	2,059	1,390	884	543
May	1,823	3,484	1,710	1,342	882	600	1,824	3,473	1,716	1,368	875	600
Jun	1,436	3,874	672	413	348	257	1,443	3,885	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	699	548	371	343	261
Sep	481	722	548	360	344	261	482	725	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition All	Baseline Condition Wet	Baseline Condition Above Normal	Baseline Condition Below Normal	Baseline Condition Dry	Baseline Condition Critical	Proposed Action All	Proposed Action Wet	Proposed Action Above Normal	Proposed Action Below Normal	Proposed Action Dry	Proposed Action Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	830	1,049	1,422	585	500	378	834	1,049	1,439	585	500	378
Jan	1,262	2,385	1,620	548	547	381	1,259	2,374	1,620	548	547	381
Feb	1,683	3,420	2,070	696	543	419	1,695	3,455	2,078	696	543	419
Mar	2,115	4,508	2,378	819	742	430	2,117	4,513	2,381	818	742	430
Apr	1,985	3,759	2,145	1,419	850	543	1,963	3,740	2,059	1,390	884	543
May	1,823	3,484	1,710	1,342	882	600	1,824	3,473	1,716	1,368	875	600
Jun	1,436	3,874	672	413	348	257	1,443	3,885	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	699	548	371	343	261
Sep	481	722	548	360	344	261	482	725	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition All	Baseline Condition Wet	Baseline Condition Above Normal	Baseline Condition Below Normal	Baseline Condition Dry	Baseline Condition Critical	Proposed Action All	Proposed Action Wet	Proposed Action Above Normal	Proposed Action Below Normal	Proposed Action Dry	Proposed Action Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	830	1,049	1,422	585	500	378	834	1,049	1,439	585	500	378
Jan	1,262	2,385	1,620	548	547	381	1,259	2,374	1,620	548	547	381
Feb	1,683	3,420	2,070	696	543	419	1,695	3,455	2,078	696	543	419
Mar	2,115	4,508	2,378	819	742	430	2,117	4,513	2,381	818	742	430
Apr	1,985	3,759	2,145	1,419	850	543	1,963	3,740	2,059	1,390	884	543
May	1,823	3,484	1,710	1,342	882	600	1,824	3,473	1,716	1,368	875	600
Jun	1,436	3,874	672	413	348	257	1,443	3,885	690	413	348	257
Jul	1,103	2,856	549	374	329	247	1,103	2,856	549	374	329	247
Aug	476	699	548	371	343	261	476	699	548	371	343	261
Sep	481	722	548	360	344	261	482	725	548	360	344	261

RPA Scenario 6

Tuolumne River Downstream From Don Pedro

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,037	934	1,013	1,160	927	1,011	1,037	934	1,013	1,160	926
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	731	896	1,335	490	402	345	739	891	1,383	490	402	345
Jan	1,263	2,286	1,617	581	566	495	1,262	2,281	1,617	581	566	495
Feb	1,718	3,360	2,020	801	649	566	1,735	3,403	2,029	817	649	566
Mar	2,523	4,532	2,479	1,419	1,463	1,313	2,522	4,516	2,495	1,421	1,463	1,312
Apr	3,309	4,469	3,243	3,127	2,907	2,110	3,287	4,451	3,184	3,102	2,901	2,110
May	3,614	5,320	3,746	3,123	2,876	1,920	3,604	5,296	3,702	3,185	2,863	1,913
Jun	3,330	5,931	2,802	2,374	2,313	1,560	3,337	5,956	2,801	2,374	2,312	1,560
Jul	3,427	5,339	3,112	2,807	2,801	1,885	3,426	5,339	3,112	2,807	2,797	1,885
Aug	2,443	2,835	2,704	2,420	2,418	1,635	2,444	2,839	2,704	2,420	2,415	1,636
Sep	1,475	1,795	1,683	1,458	1,362	892	1,475	1,795	1,683	1,458	1,361	892

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,037	934	1,013	1,160	927	1,011	1,037	934	1,013	1,160	926
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	731	896	1,335	490	402	345	739	891	1,383	490	402	345
Jan	1,263	2,286	1,617	581	566	495	1,262	2,281	1,617	581	566	495
Feb	1,718	3,360	2,020	801	649	566	1,735	3,403	2,029	817	649	566
Mar	2,523	4,532	2,479	1,419	1,463	1,313	2,522	4,516	2,495	1,421	1,463	1,312
Apr	3,309	4,469	3,243	3,127	2,907	2,110	3,287	4,451	3,184	3,102	2,901	2,110
May	3,614	5,320	3,746	3,123	2,876	1,920	3,604	5,296	3,702	3,185	2,863	1,913
Jun	3,330	5,931	2,802	2,374	2,313	1,560	3,337	5,956	2,801	2,374	2,312	1,560
Jul	3,427	5,339	3,112	2,807	2,801	1,885	3,426	5,339	3,112	2,807	2,797	1,885
Aug	2,443	2,835	2,704	2,420	2,418	1,635	2,444	2,839	2,704	2,420	2,415	1,636
Sep	1,475	1,795	1,683	1,458	1,362	892	1,475	1,795	1,683	1,458	1,361	892

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,011	1,037	934	1,013	1,160	927	1,011	1,037	934	1,013	1,160	926
Nov	407	414	570	334	376	316	407	414	570	334	376	316
Dec	731	896	1,335	490	402	345	739	891	1,383	490	402	345
Jan	1,263	2,286	1,617	581	566	495	1,262	2,281	1,617	581	566	495
Feb	1,718	3,360	2,020	801	649	566	1,735	3,403	2,029	817	649	566
Mar	2,523	4,532	2,479	1,419	1,463	1,313	2,522	4,516	2,495	1,421	1,463	1,312
Apr	3,309	4,469	3,243	3,127	2,907	2,110	3,287	4,451	3,184	3,102	2,901	2,110
May	3,614	5,320	3,746	3,123	2,876	1,920	3,604	5,296	3,702	3,185	2,863	1,913
Jun	3,330	5,931	2,802	2,374	2,313	1,560	3,337	5,956	2,801	2,374	2,312	1,560
Jul	3,427	5,339	3,112	2,807	2,801	1,885	3,426	5,339	3,112	2,807	2,797	1,885
Aug	2,443	2,835	2,704	2,420	2,418	1,635	2,444	2,839	2,704	2,420	2,415	1,636
Sep	1,475	1,795	1,683	1,458	1,362	892	1,475	1,795	1,683	1,458	1,361	892

RPA Scenario 6

Tuolumne River Upstream from the San Joaquin River Confluence

Chinook Salmon Spawning, Incubation and Fry Rearing (Target Flow = 275 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	842	1,061	1,463	585	500	378	850	1,056	1,512	585	500	378
Jan	1,288	2,472	1,620	548	547	381	1,286	2,467	1,620	548	547	381
Feb	1,700	3,450	2,069	747	543	419	1,717	3,494	2,078	763	543	419
Mar	2,138	4,542	2,382	897	742	430	2,136	4,525	2,398	898	742	430
Apr	1,915	3,740	2,055	1,319	727	486	1,894	3,723	1,992	1,299	726	486
May	1,769	3,480	1,697	1,229	765	527	1,761	3,457	1,660	1,285	755	520
Jun	1,449	3,890	714	413	348	257	1,455	3,914	710	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	480	713	548	371	343	261	481	717	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	842	1,061	1,463	585	500	378	850	1,056	1,512	585	500	378
Jan	1,288	2,472	1,620	548	547	381	1,286	2,467	1,620	548	547	381
Feb	1,700	3,450	2,069	747	543	419	1,717	3,494	2,078	763	543	419
Mar	2,138	4,542	2,382	897	742	430	2,136	4,525	2,398	898	742	430
Apr	1,915	3,740	2,055	1,319	727	486	1,894	3,723	1,992	1,299	726	486
May	1,769	3,480	1,697	1,229	765	527	1,761	3,457	1,660	1,285	755	520
Jun	1,449	3,890	714	413	348	257	1,455	3,914	710	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	480	713	548	371	343	261	481	717	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Chinook Salmon Juvenile Migration (Target Flow = 1,100 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	597	654	617	550	639	494	597	654	617	550	639	494
Nov	574	591	797	458	528	453	574	591	797	458	528	453
Dec	842	1,061	1,463	585	500	378	850	1,056	1,512	585	500	378
Jan	1,288	2,472	1,620	548	547	381	1,286	2,467	1,620	548	547	381
Feb	1,700	3,450	2,069	747	543	419	1,717	3,494	2,078	763	543	419
Mar	2,138	4,542	2,382	897	742	430	2,136	4,525	2,398	898	742	430
Apr	1,915	3,740	2,055	1,319	727	486	1,894	3,723	1,992	1,299	726	486
May	1,769	3,480	1,697	1,229	765	527	1,761	3,457	1,660	1,285	755	520
Jun	1,449	3,890	714	413	348	257	1,455	3,914	710	413	348	257
Jul	1,105	2,856	561	374	329	247	1,105	2,856	561	374	329	247
Aug	480	713	548	371	343	261	481	717	548	371	343	261
Sep	482	727	548	360	344	261	482	727	548	360	344	261

Attachment 7

Flow Requirement Tables for Steelhead in the Stanislaus River

Appendix B

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2011

No RPA Scenario

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

No RPA Scenario

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	711	727	803	671	797	560	715	732	805	675	800	562
Nov	519	550	647	472	479	412	529	561	659	479	496	416
Dec	587	683	864	462	452	376	602	694	906	468	469	380
Jan	669	1,013	930	422	440	279	671	1,015	931	426	444	281
Feb	894	1,603	950	499	550	376	893	1,648	951	464	509	362
Mar	835	1,581	631	468	464	517	757	1,613	598	419	347	239
Apr	1,200	1,648	1,394	1,110	972	591	1,200	1,671	1,408	1,117	930	569
May	1,148	1,553	1,313	1,082	948	591	1,168	1,561	1,346	1,117	956	614
Jun	969	2,012	944	539	329	298	968	1,998	927	540	338	322
Jul	606	1,147	451	425	344	312	612	1,166	451	425	345	313
Aug	581	1,042	444	407	371	339	582	1,043	444	407	371	340
Sep	624	1,161	472	407	387	338	631	1,183	473	408	387	338

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	711	727	803	671	797	560	715	732	805	675	800	562
Nov	519	550	647	472	479	412	529	561	659	479	496	416
Dec	587	683	864	462	452	376	602	694	906	468	469	380
Jan	669	1,013	930	422	440	279	671	1,015	931	426	444	281
Feb	894	1,603	950	499	550	376	893	1,648	951	464	509	362
Mar	835	1,581	631	468	464	517	757	1,613	598	419	347	239
Apr	1,200	1,648	1,394	1,110	972	591	1,200	1,671	1,408	1,117	930	569
May	1,148	1,553	1,313	1,082	948	591	1,168	1,561	1,346	1,117	956	614
Jun	969	2,012	944	539	329	298	968	1,998	927	540	338	322
Jul	606	1,147	451	425	344	312	612	1,166	451	425	345	313
Aug	581	1,042	444	407	371	339	582	1,043	444	407	371	340
Sep	624	1,161	472	407	387	338	631	1,183	473	408	387	338

RPA Scenario 1

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

RPA Scenario 1

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition All	Baseline Condition Wet	Baseline Condition Above Normal	Baseline Condition Below Normal	Baseline Condition Dry	Baseline Condition Critical	Proposed Action All	Proposed Action Wet	Proposed Action Above Normal	Proposed Action Below Normal	Proposed Action Dry	Proposed Action Critical
Oct	859	876	876	899	995	676	864	885	877	903	995	684
Nov	412	429	585	341	345	325	413	430	586	341	345	327
Dec	451	512	727	331	317	289	462	549	728	331	317	290
Jan	635	952	843	419	406	313	632	953	843	419	406	297
Feb	793	1,210	905	533	520	490	764	1,203	896	501	467	427
Mar	1,130	2,042	1,208	645	559	541	1,054	2,080	1,238	633	317	271
Apr	1,581	2,055	1,940	1,668	1,321	653	1,416	2,010	1,568	1,416	1,091	635
May	1,317	1,765	1,585	1,124	1,179	644	1,477	1,760	1,866	1,597	1,367	656
Jun	890	1,564	1,039	618	418	333	917	1,581	1,084	671	434	348
Jul	610	1,079	488	447	397	336	622	1,110	490	452	402	337
Aug	562	933	475	421	387	349	565	933	476	423	387	362
Sep	588	1,023	499	413	395	324	594	1,025	502	417	395	343

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition All	Baseline Condition Wet	Baseline Condition Above Normal	Baseline Condition Below Normal	Baseline Condition Dry	Baseline Condition Critical	Proposed Action All	Proposed Action Wet	Proposed Action Above Normal	Proposed Action Below Normal	Proposed Action Dry	Proposed Action Critical
Oct	859	876	876	899	995	676	864	885	877	903	995	684
Nov	412	429	585	341	345	325	413	430	586	341	345	327
Dec	451	512	727	331	317	289	462	549	728	331	317	290
Jan	635	952	843	419	406	313	632	953	843	419	406	297
Feb	793	1,210	905	533	520	490	764	1,203	896	501	467	427
Mar	1,130	2,042	1,208	645	559	541	1,054	2,080	1,238	633	317	271
Apr	1,581	2,055	1,940	1,668	1,321	653	1,416	2,010	1,568	1,416	1,091	635
May	1,317	1,765	1,585	1,124	1,179	644	1,477	1,760	1,866	1,597	1,367	656
Jun	890	1,564	1,039	618	418	333	917	1,581	1,084	671	434	348
Jul	610	1,079	488	447	397	336	622	1,110	490	452	402	337
Aug	562	933	475	421	387	349	565	933	476	423	387	362
Sep	588	1,023	499	413	395	324	594	1,025	502	417	395	343

RPA Scenario 2

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893
Nov	533	541	642	488	503	473
Dec	494	517	738	393	402	372
Jan	612	860	851	391	400	353
Feb	716	844	860	547	588	623
Mar	1,329	1,850	1,219	1,019	1,034	1,149
Apr	2,433	2,533	2,695	2,586	2,415	1,909
May	2,653	3,019	2,990	2,485	2,591	1,954
Jun	2,327	2,914	2,506	2,208	2,057	1,585
Jul	2,203	2,599	2,259	2,198	2,146	1,603
Aug	1,997	2,342	2,088	2,020	1,941	1,413
Sep	1,394	1,707	1,429	1,378	1,268	1,007

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,092	1,144	1,064	1,145	1,221	892
Nov	535	542	643	488	509	475
Dec	494	515	739	393	409	370
Jan	611	860	858	391	407	333
Feb	688	841	861	506	535	555
Mar	1,224	1,881	1,199	918	804	855
Apr	2,271	2,480	2,311	2,330	2,224	1,906
May	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,226	2,607	2,260	2,200	2,177	1,680
Aug	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,401	1,729	1,429	1,378	1,268	1,010

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893
Nov	533	541	642	488	503	473
Dec	494	517	738	393	402	372
Jan	612	860	851	391	400	353
Feb	716	844	860	547	588	623
Mar	1,329	1,850	1,219	1,019	1,034	1,149
Apr	2,433	2,533	2,695	2,586	2,415	1,909
May	2,653	3,019	2,990	2,485	2,591	1,954
Jun	2,327	2,914	2,506	2,208	2,057	1,585
Jul	2,203	2,599	2,259	2,198	2,146	1,603
Aug	1,997	2,342	2,088	2,020	1,941	1,413
Sep	1,394	1,707	1,429	1,378	1,268	1,007

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,092	1,144	1,064	1,145	1,221	892
Nov	535	542	643	488	509	475
Dec	494	515	739	393	409	370
Jan	611	860	858	391	407	333
Feb	688	841	861	506	535	555
Mar	1,224	1,881	1,199	918	804	855
Apr	2,271	2,480	2,311	2,330	2,224	1,906
May	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,226	2,607	2,260	2,200	2,177	1,680
Aug	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,401	1,729	1,429	1,378	1,268	1,010

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893
Nov	533	541	642	488	503	473
Dec	494	517	738	393	402	372
Jan	612	860	851	391	400	353
Feb	716	844	860	547	588	623
Mar	1,329	1,850	1,219	1,019	1,034	1,149
Apr	2,433	2,533	2,695	2,586	2,415	1,909
May	2,653	3,019	2,990	2,485	2,591	1,954
Jun	2,327	2,914	2,506	2,208	2,057	1,585
Jul	2,203	2,599	2,259	2,198	2,146	1,603
Aug	1,997	2,342	2,088	2,020	1,941	1,413
Sep	1,394	1,707	1,429	1,378	1,268	1,007

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,092	1,144	1,064	1,145	1,221	892
Nov	535	542	643	488	509	475
Dec	494	515	739	393	409	370
Jan	611	860	858	391	407	333
Feb	688	841	861	506	535	555
Mar	1,224	1,881	1,199	918	804	855
Apr	2,271	2,480	2,311	2,330	2,224	1,906
May	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,226	2,607	2,260	2,200	2,177	1,680
Aug	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,401	1,729	1,429	1,378	1,268	1,010

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893
Nov	533	541	642	488	503	473
Dec	494	517	738	393	402	372
Jan	612	860	851	391	400	353
Feb	716	844	860	547	588	623
Mar	1,329	1,850	1,219	1,019	1,034	1,149
Apr	2,433	2,533	2,695	2,586	2,415	1,909
May	2,653	3,019	2,990	2,485	2,591	1,954
Jun	2,327	2,914	2,506	2,208	2,057	1,585
Jul	2,203	2,599	2,259	2,198	2,146	1,603
Aug	1,997	2,342	2,088	2,020	1,941	1,413
Sep	1,394	1,707	1,429	1,378	1,268	1,007

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,092	1,144	1,064	1,145	1,221	892
Nov	535	542	643	488	509	475
Dec	494	515	739	393	409	370
Jan	611	860	858	391	407	333
Feb	688	841	861	506	535	555
Mar	1,224	1,881	1,199	918	804	855
Apr	2,271	2,480	2,311	2,330	2,224	1,906
May	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,226	2,607	2,260	2,200	2,177	1,680
Aug	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,401	1,729	1,429	1,378	1,268	1,010

RPA Scenario 2

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition							Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical		All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	778	815	786	791	933	578		790	825	828	791	936	577
Nov	394	414	564	334	321	303		396	414	565	334	328	305
Dec	407	407	702	323	294	271		407	405	703	323	301	269
Jan	572	836	819	343	366	281		571	837	825	343	374	261
Feb	665	876	838	467	482	484		636	873	839	427	428	416
Mar	992	1,725	1,006	633	540	538		887	1,755	986	532	310	244
Apr	1,413	1,903	1,802	1,350	1,095	600		1,249	1,850	1,418	1,094	905	582
May	1,161	1,585	1,414	986	986	558		1,316	1,607	1,665	1,331	1,205	606
Jun	792	1,362	915	601	408	282		811	1,355	967	612	427	314
Jul	533	869	478	447	397	263		540	877	479	449	402	284
Aug	489	735	467	421	380	287		491	738	467	421	380	288
Sep	521	834	487	413	391	278		528	856	487	413	391	281

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition							Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical		All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	778	815	786	791	933	578		790	825	828	791	936	577
Nov	394	414	564	334	321	303		396	414	565	334	328	305
Dec	407	407	702	323	294	271		407	405	703	323	301	269
Jan	572	836	819	343	366	281		571	837	825	343	374	261
Feb	665	876	838	467	482	484		636	873	839	427	428	416
Mar	992	1,725	1,006	633	540	538		887	1,755	986	532	310	244
Apr	1,413	1,903	1,802	1,350	1,095	600		1,249	1,850	1,418	1,094	905	582
May	1,161	1,585	1,414	986	986	558		1,316	1,607	1,665	1,331	1,205	606
Jun	792	1,362	915	601	408	282		811	1,355	967	612	427	314
Jul	533	869	478	447	397	263		540	877	479	449	402	284
Aug	489	735	467	421	380	287		491	738	467	421	380	288
Sep	521	834	487	413	391	278		528	856	487	413	391	281

RPA Scenario 3

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

RPA Scenario 3

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	862	892	876	899	984	673	864	888	877	903	995	675
Nov	410	427	585	341	345	319	412	428	587	341	345	326
Dec	447	503	727	331	317	283	458	538	725	331	317	290
Jan	634	956	843	419	405	305	632	953	844	419	406	297
Feb	779	1,163	904	539	521	484	758	1,183	896	501	468	427
Mar	1,141	2,032	1,281	645	559	540	1,038	2,026	1,238	633	318	272
Apr	1,607	2,040	1,978	1,720	1,386	673	1,428	2,010	1,575	1,385	1,165	656
May	1,373	1,738	1,687	1,218	1,281	710	1,541	1,761	1,962	1,746	1,415	727
Jun	886	1,527	1,084	610	418	331	922	1,592	1,084	665	449	348
Jul	597	1,031	489	447	397	335	619	1,100	490	452	402	337
Aug	560	929	476	421	387	345	565	933	476	423	387	362
Sep	588	1,019	502	413	395	324	593	1,023	502	417	395	343

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	862	892	876	899	984	673	864	888	877	903	995	675
Nov	410	427	585	341	345	319	412	428	587	341	345	326
Dec	447	503	727	331	317	283	458	538	725	331	317	290
Jan	634	956	843	419	405	305	632	953	844	419	406	297
Feb	779	1,163	904	539	521	484	758	1,183	896	501	468	427
Mar	1,141	2,032	1,281	645	559	540	1,038	2,026	1,238	633	318	272
Apr	1,607	2,040	1,978	1,720	1,386	673	1,428	2,010	1,575	1,385	1,165	656
May	1,373	1,738	1,687	1,218	1,281	710	1,541	1,761	1,962	1,746	1,415	727
Jun	886	1,527	1,084	610	418	331	922	1,592	1,084	665	449	348
Jul	597	1,031	489	447	397	335	619	1,100	490	452	402	337
Aug	560	929	476	421	387	345	565	933	476	423	387	362
Sep	588	1,019	502	413	395	324	593	1,023	502	417	395	343

RPA Scenario 4

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

RPA Scenario 4

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	850	875	876	852	984	676	861	902	876	863	995	672
Nov	411	427	585	341	345	325	410	427	585	341	345	319
Dec	445	495	723	331	317	288	450	513	725	331	317	283
Jan	634	951	842	414	405	313	631	956	843	414	406	288
Feb	786	1,185	905	534	521	490	755	1,185	896	487	468	419
Mar	1,111	2,029	1,135	645	559	540	1,034	2,016	1,238	633	318	265
Apr	1,680	2,087	1,992	1,849	1,538	738	1,478	2,015	1,635	1,381	1,297	738
May	1,442	1,802	1,705	1,322	1,400	770	1,578	1,748	2,002	1,775	1,521	785
Jun	863	1,504	1,004	610	418	331	898	1,512	1,084	665	447	348
Jul	581	984	486	447	397	329	602	1,043	490	452	402	337
Aug	540	864	474	421	387	340	564	929	476	423	387	361
Sep	588	1,023	496	413	395	324	591	1,019	502	417	395	337

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	850	875	876	852	984	676	861	902	876	863	995	672
Nov	411	427	585	341	345	325	410	427	585	341	345	319
Dec	445	495	723	331	317	288	450	513	725	331	317	283
Jan	634	951	842	414	405	313	631	956	843	414	406	288
Feb	786	1,185	905	534	521	490	755	1,185	896	487	468	419
Mar	1,111	2,029	1,135	645	559	540	1,034	2,016	1,238	633	318	265
Apr	1,680	2,087	1,992	1,849	1,538	738	1,478	2,015	1,635	1,381	1,297	738
May	1,442	1,802	1,705	1,322	1,400	770	1,578	1,748	2,002	1,775	1,521	785
Jun	863	1,504	1,004	610	418	331	898	1,512	1,084	665	447	348
Jul	581	984	486	447	397	329	602	1,043	490	452	402	337
Aug	540	864	474	421	387	340	564	929	476	423	387	361
Sep	588	1,023	496	413	395	324	591	1,019	502	417	395	337

RPA Scenario 5

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

RPA Scenario 5

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	776	810	783	791	933	578	792	823	816	791	933	606
Nov	394	414	564	334	321	303	395	414	564	334	321	305
Dec	399	407	660	323	294	271	405	402	702	323	294	269
Jan	570	836	811	343	366	281	570	837	824	343	366	266
Feb	661	860	837	473	483	484	641	896	838	427	421	416
Mar	986	1,705	1,006	633	540	538	894	1,775	986	532	310	249
Apr	1,440	1,887	1,798	1,444	1,173	627	1,254	1,833	1,425	1,092	924	617
May	1,231	1,638	1,466	1,122	1,070	606	1,375	1,622	1,757	1,448	1,230	683
Jun	789	1,362	916	601	408	264	810	1,350	967	612	427	314
Jul	530	860	478	447	397	263	539	873	479	449	402	284
Aug	489	735	467	421	380	287	489	735	467	421	380	288
Sep	519	827	487	413	391	278	523	841	487	413	391	281

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	776	810	783	791	933	578	792	823	816	791	933	606
Nov	394	414	564	334	321	303	395	414	564	334	321	305
Dec	399	407	660	323	294	271	405	402	702	323	294	269
Jan	570	836	811	343	366	281	570	837	824	343	366	266
Feb	661	860	837	473	483	484	641	896	838	427	421	416
Mar	986	1,705	1,006	633	540	538	894	1,775	986	532	310	249
Apr	1,440	1,887	1,798	1,444	1,173	627	1,254	1,833	1,425	1,092	924	617
May	1,231	1,638	1,466	1,122	1,070	606	1,375	1,622	1,757	1,448	1,230	683
Jun	789	1,362	916	601	408	264	810	1,350	967	612	427	314
Jul	530	860	478	447	397	263	539	873	479	449	402	284
Aug	489	735	467	421	380	287	489	735	467	421	380	288
Sep	519	827	487	413	391	278	523	841	487	413	391	281

RPA Scenario 6

Stanislaus River Upstream From Goodwin Dam

Steelhead Spawning (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	fa

Steelhead Incubation and Fry Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

RPA Scenario 6

Stanislaus River Upstream From the San Joaquin River

Steelhead Juvenile Rearing (Target Flow = 150 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	773	807	782	791	920	578	783	814	812	791	933	577
Nov	393	410	563	334	321	302	394	414	564	334	321	304
Dec	401	416	659	323	294	270	397	402	660	323	294	268
Jan	565	836	784	343	365	281	565	836	804	343	366	260
Feb	675	927	837	473	482	456	646	911	838	427	421	416
Mar	942	1,636	884	633	540	538	859	1,708	914	532	310	244
Apr	1,504	1,902	1,890	1,470	1,356	669	1,315	1,855	1,492	1,186	1,056	645
May	1,284	1,652	1,536	1,135	1,241	636	1,422	1,647	1,755	1,544	1,342	717
Jun	767	1,331	863	593	408	259	802	1,350	933	612	423	314
Jul	520	826	475	447	397	263	533	867	477	449	402	264
Aug	487	730	465	421	380	287	489	735	466	421	380	288
Sep	514	821	481	413	391	268	519	827	483	413	391	281

Steelhead Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	773	807	782	791	920	578	783	814	812	791	933	577
Nov	393	410	563	334	321	302	394	414	564	334	321	304
Dec	401	416	659	323	294	270	397	402	660	323	294	268
Jan	565	836	784	343	365	281	565	836	804	343	366	260
Feb	675	927	837	473	482	456	646	911	838	427	421	416
Mar	942	1,636	884	633	540	538	859	1,708	914	532	310	244
Apr	1,504	1,902	1,890	1,470	1,356	669	1,315	1,855	1,492	1,186	1,056	645
May	1,284	1,652	1,536	1,135	1,241	636	1,422	1,647	1,755	1,544	1,342	717
Jun	767	1,331	863	593	408	259	802	1,350	933	612	423	314
Jul	520	826	475	447	397	263	533	867	477	449	402	264
Aug	487	730	465	421	380	287	489	735	466	421	380	288
Sep	514	821	481	413	391	268	519	827	483	413	391	281

Attachment 8

Flow Requirement Tables for Chinook Salmon in the Stanislaus River

Appendix B

SAN JOAQUIN RIVER RESTORATION PROGRAM

November 2011

No RPA Scenario

Stanislaus River Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	936	981	995	928	989	771	938	984	994	935	991	773
Nov	595	616	667	558	598	519	604	627	678	564	610	523
Dec	627	749	857	482	513	424	643	760	899	489	530	428
Jan	679	1,009	936	439	444	312	681	1,011	936	443	448	313
Feb	923	1,550	953	556	636	484	922	1,596	954	521	595	470
Mar	1,137	1,683	820	823	919	1,066	1,059	1,714	788	774	803	788
Apr	2,155	2,252	2,273	2,293	2,184	1,752	2,148	2,269	2,263	2,302	2,145	1,727
May	2,520	2,928	2,814	2,446	2,383	1,785	2,541	2,930	2,847	2,493	2,396	1,807
Jun	2,351	3,473	2,415	1,921	1,741	1,449	2,350	3,459	2,389	1,935	1,749	1,473
Jul	2,104	2,773	2,094	1,914	1,815	1,500	2,110	2,792	2,088	1,928	1,813	1,501
Aug	1,963	2,554	1,943	1,803	1,715	1,428	1,962	2,549	1,935	1,810	1,716	1,430
Sep	1,357	1,937	1,255	1,169	1,073	974	1,370	1,963	1,285	1,167	1,070	977

No RPA Scenario

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	711	727	803	671	797	560
Nov	519	550	647	472	479	412
Dec	587	683	864	462	452	376
Jan	669	1,013	930	422	440	279
Feb	894	1,603	950	499	550	376
Mar	835	1,581	631	468	464	517
Apr	1,200	1,648	1,394	1,110	972	591
May	1,148	1,553	1,313	1,082	948	591
Jun	969	2,012	944	539	329	298
Jul	606	1,147	451	425	344	312
Aug	581	1,042	444	407	371	339
Sep	624	1,161	472	407	387	338

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	715	732	805	675	800	562
Nov	529	561	659	479	496	416
Dec	602	694	906	468	469	380
Jan	671	1,015	931	426	444	281
Feb	893	1,648	951	464	509	362
Mar	757	1,613	598	419	347	239
Apr	1,200	1,671	1,408	1,117	930	569
May	1,168	1,561	1,346	1,117	956	614
Jun	968	1,998	927	540	338	322
Jul	612	1,166	451	425	345	313
Aug	582	1,043	444	407	371	340
Sep	631	1,183	473	408	387	338

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	711	727	803	671	797	560
Nov	519	550	647	472	479	412
Dec	587	683	864	462	452	376
Jan	669	1,013	930	422	440	279
Feb	894	1,603	950	499	550	376
Mar	835	1,581	631	468	464	517
Apr	1,200	1,648	1,394	1,110	972	591
May	1,148	1,553	1,313	1,082	948	591
Jun	969	2,012	944	539	329	298
Jul	606	1,147	451	425	344	312
Aug	581	1,042	444	407	371	339
Sep	624	1,161	472	407	387	338

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	715	732	805	675	800	562
Nov	529	561	659	479	496	416
Dec	602	694	906	468	469	380
Jan	671	1,015	931	426	444	281
Feb	893	1,648	951	464	509	362
Mar	757	1,613	598	419	347	239
Apr	1,200	1,671	1,408	1,117	930	569
May	1,168	1,561	1,346	1,117	956	614
Jun	968	1,998	927	540	338	322
Jul	612	1,166	451	425	345	313
Aug	582	1,043	444	407	371	340
Sep	631	1,183	473	408	387	338

RPA Scenario 1

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,111	1,062	1,160	1,190	897	1,087	1,128	1,062	1,165	1,190	905
Nov	486	494	603	426	458	427	487	495	604	426	458	429
Dec	491	577	720	351	378	337	502	614	721	351	378	338
Jan	640	943	844	432	404	344	638	944	845	432	405	329
Feb	811	1,146	897	579	593	590	782	1,139	888	548	541	527
Mar	1,423	2,130	1,387	993	1,008	1,084	1,347	2,168	1,418	981	767	815
Apr	2,507	2,640	2,772	2,807	2,496	1,808	2,342	2,596	2,400	2,556	2,267	1,790
May	2,649	3,115	3,009	2,434	2,568	1,833	2,812	3,113	3,294	2,909	2,757	1,845
Jun	2,221	2,994	2,405	1,922	1,779	1,478	2,253	3,017	2,456	1,981	1,797	1,494
Jul	2,052	2,668	2,016	1,850	1,817	1,519	2,068	2,707	2,024	1,862	1,824	1,520
Aug	1,902	2,415	1,892	1,750	1,694	1,435	1,908	2,420	1,898	1,756	1,695	1,448
Sep	1,343	1,799	1,312	1,218	1,128	966	1,352	1,803	1,317	1,224	1,129	998

RPA Scenario 1

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	859	876	876	899	995	676
Nov	412	429	585	341	345	325
Dec	451	512	727	331	317	289
Jan	635	952	843	419	406	313
Feb	793	1,210	905	533	520	490
Mar	1,130	2,042	1,208	645	559	541
Apr	1,581	2,055	1,940	1,668	1,321	653
May	1,317	1,765	1,585	1,124	1,179	644
Jun	890	1,564	1,039	618	418	333
Jul	610	1,079	488	447	397	336
Aug	562	933	475	421	387	349
Sep	588	1,023	499	413	395	324

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	864	885	877	903	995	684
Nov	413	430	586	341	345	327
Dec	462	549	728	331	317	290
Jan	632	953	843	419	406	297
Feb	764	1,203	896	501	467	427
Mar	1,054	2,080	1,238	633	317	271
Apr	1,416	2,010	1,568	1,416	1,091	635
May	1,477	1,760	1,866	1,597	1,367	656
Jun	917	1,581	1,084	671	434	348
Jul	622	1,110	490	452	402	337
Aug	565	933	476	423	387	362
Sep	594	1,025	502	417	395	343

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

Baseline Condition

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	859	876	876	899	995	676
Nov	412	429	585	341	345	325
Dec	451	512	727	331	317	289
Jan	635	952	843	419	406	313
Feb	793	1,210	905	533	520	490
Mar	1,130	2,042	1,208	645	559	541
Apr	1,581	2,055	1,940	1,668	1,321	653
May	1,317	1,765	1,585	1,124	1,179	644
Jun	890	1,564	1,039	618	418	333
Jul	610	1,079	488	447	397	336
Aug	562	933	475	421	387	349
Sep	588	1,023	499	413	395	324

Proposed Action

	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	864	885	877	903	995	684
Nov	413	430	586	341	345	327
Dec	462	549	728	331	317	290
Jan	632	953	843	419	406	297
Feb	764	1,203	896	501	467	427
Mar	1,054	2,080	1,238	633	317	271
Apr	1,416	2,010	1,568	1,416	1,091	635
May	1,477	1,760	1,866	1,597	1,367	656
Jun	917	1,581	1,084	671	434	348
Jul	622	1,110	490	452	402	337
Aug	565	933	476	423	387	362
Sep	594	1,025	502	417	395	343

RPA Scenario 2

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893	1,092	1,144	1,064	1,145	1,221	892
Nov	533	541	642	488	503	473	535	542	643	488	509	475
Dec	494	517	738	393	402	372	494	515	739	393	409	370
Jan	612	860	851	391	400	353	611	860	858	391	407	333
Feb	716	844	860	547	588	623	688	841	861	506	535	555
Mar	1,329	1,850	1,219	1,019	1,034	1,149	1,224	1,881	1,199	918	804	855
Apr	2,433	2,533	2,695	2,586	2,415	1,909	2,271	2,480	2,311	2,330	2,224	1,906
May	2,653	3,019	2,990	2,485	2,591	1,954	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,327	2,914	2,506	2,208	2,057	1,585	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,203	2,599	2,259	2,198	2,146	1,603	2,226	2,607	2,260	2,200	2,177	1,680
Aug	1,997	2,342	2,088	2,020	1,941	1,413	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,394	1,707	1,429	1,378	1,268	1,007	1,401	1,729	1,429	1,378	1,268	1,010

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893	1,092	1,144	1,064	1,145	1,221	892
Nov	533	541	642	488	503	473	535	542	643	488	509	475
Dec	494	517	738	393	402	372	494	515	739	393	409	370
Jan	612	860	851	391	400	353	611	860	858	391	407	333
Feb	716	844	860	547	588	623	688	841	861	506	535	555
Mar	1,329	1,850	1,219	1,019	1,034	1,149	1,224	1,881	1,199	918	804	855
Apr	2,433	2,533	2,695	2,586	2,415	1,909	2,271	2,480	2,311	2,330	2,224	1,906
May	2,653	3,019	2,990	2,485	2,591	1,954	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,327	2,914	2,506	2,208	2,057	1,585	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,203	2,599	2,259	2,198	2,146	1,603	2,226	2,607	2,260	2,200	2,177	1,680
Aug	1,997	2,342	2,088	2,020	1,941	1,413	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,394	1,707	1,429	1,378	1,268	1,007	1,401	1,729	1,429	1,378	1,268	1,010

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893	1,092	1,144	1,064	1,145	1,221	892
Nov	533	541	642	488	503	473	535	542	643	488	509	475
Dec	494	517	738	393	402	372	494	515	739	393	409	370
Jan	612	860	851	391	400	353	611	860	858	391	407	333
Feb	716	844	860	547	588	623	688	841	861	506	535	555
Mar	1,329	1,850	1,219	1,019	1,034	1,149	1,224	1,881	1,199	918	804	855
Apr	2,433	2,533	2,695	2,586	2,415	1,909	2,271	2,480	2,311	2,330	2,224	1,906
May	2,653	3,019	2,990	2,485	2,591	1,954	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,327	2,914	2,506	2,208	2,057	1,585	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,203	2,599	2,259	2,198	2,146	1,603	2,226	2,607	2,260	2,200	2,177	1,680
Aug	1,997	2,342	2,088	2,020	1,941	1,413	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,394	1,707	1,429	1,378	1,268	1,007	1,401	1,729	1,429	1,378	1,268	1,010

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition All	Wet	Above Normal	Below Normal	Dry	Critical	Proposed Action All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,080	1,134	1,023	1,145	1,219	893	1,092	1,144	1,064	1,145	1,221	892
Nov	533	541	642	488	503	473	535	542	643	488	509	475
Dec	494	517	738	393	402	372	494	515	739	393	409	370
Jan	612	860	851	391	400	353	611	860	858	391	407	333
Feb	716	844	860	547	588	623	688	841	861	506	535	555
Mar	1,329	1,850	1,219	1,019	1,034	1,149	1,224	1,881	1,199	918	804	855
Apr	2,433	2,533	2,695	2,586	2,415	1,909	2,271	2,480	2,311	2,330	2,224	1,906
May	2,653	3,019	2,990	2,485	2,591	1,954	2,811	3,042	3,241	2,830	2,826	2,010
Jun	2,327	2,914	2,506	2,208	2,057	1,585	2,363	2,907	2,558	2,219	2,085	1,695
Jul	2,203	2,599	2,259	2,198	2,146	1,603	2,226	2,607	2,260	2,200	2,177	1,680
Aug	1,997	2,342	2,088	2,020	1,941	1,413	2,009	2,345	2,088	2,020	1,941	1,471
Sep	1,394	1,707	1,429	1,378	1,268	1,007	1,401	1,729	1,429	1,378	1,268	1,010

RPA Scenario 2

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	778	815	786	791	933	578	790	825	828	791	936	577
Nov	394	414	564	334	321	303	396	414	565	334	328	305
Dec	407	407	702	323	294	271	407	405	703	323	301	269
Jan	572	836	819	343	366	281	571	837	825	343	374	261
Feb	665	876	838	467	482	484	636	873	839	427	428	416
Mar	992	1,725	1,006	633	540	538	887	1,755	986	532	310	244
Apr	1,413	1,903	1,802	1,350	1,095	600	1,249	1,850	1,418	1,094	905	582
May	1,161	1,585	1,414	986	986	558	1,316	1,607	1,665	1,331	1,205	606
Jun	792	1,362	915	601	408	282	811	1,355	967	612	427	314
Jul	533	869	478	447	397	263	540	877	479	449	402	284
Aug	489	735	467	421	380	287	491	738	467	421	380	288
Sep	521	834	487	413	391	278	528	856	487	413	391	281

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	778	815	786	791	933	578	790	825	828	791	936	577
Nov	394	414	564	334	321	303	396	414	565	334	328	305
Dec	407	407	702	323	294	271	407	405	703	323	301	269
Jan	572	836	819	343	366	281	571	837	825	343	374	261
Feb	665	876	838	467	482	484	636	873	839	427	428	416
Mar	992	1,725	1,006	633	540	538	887	1,755	986	532	310	244
Apr	1,413	1,903	1,802	1,350	1,095	600	1,249	1,850	1,418	1,094	905	582
May	1,161	1,585	1,414	986	986	558	1,316	1,607	1,665	1,331	1,205	606
Jun	792	1,362	915	601	408	282	811	1,355	967	612	427	314
Jul	533	869	478	447	397	263	540	877	479	449	402	284
Aug	489	735	467	421	380	287	491	738	467	421	380	288
Sep	521	834	487	413	391	278	528	856	487	413	391	281

RPA Scenario 3

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,075	1,126	1,058	1,150	1,171	875	1,079	1,130	1,059	1,157	1,184	875
Nov	484	492	603	426	458	421	486	493	604	426	458	428
Dec	487	568	720	350	378	330	498	604	717	351	378	338
Jan	640	947	844	432	404	336	638	944	845	432	405	328
Feb	797	1,098	896	586	594	584	776	1,119	888	548	542	527
Mar	1,434	2,120	1,460	993	1,008	1,084	1,331	2,114	1,418	981	767	815
Apr	2,532	2,625	2,810	2,857	2,559	1,828	2,354	2,596	2,407	2,524	2,340	1,811
May	2,705	3,087	3,113	2,526	2,668	1,900	2,876	3,113	3,389	3,057	2,804	1,916
Jun	2,216	2,955	2,452	1,912	1,776	1,477	2,256	3,027	2,454	1,973	1,810	1,494
Jul	2,038	2,619	2,019	1,848	1,814	1,519	2,064	2,696	2,023	1,860	1,823	1,520
Aug	1,900	2,410	1,895	1,749	1,691	1,431	1,908	2,419	1,896	1,756	1,694	1,448
Sep	1,297	1,779	1,246	1,149	1,065	935	1,313	1,795	1,283	1,136	1,069	961

RPA Scenario 3

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	862	892	876	899	984	673	864	888	877	903	995	675
Nov	410	427	585	341	345	319	412	428	587	341	345	326
Dec	447	503	727	331	317	283	458	538	725	331	317	290
Jan	634	956	843	419	405	305	632	953	844	419	406	297
Feb	779	1,163	904	539	521	484	758	1,183	896	501	468	427
Mar	1,141	2,032	1,281	645	559	540	1,038	2,026	1,238	633	318	272
Apr	1,607	2,040	1,978	1,720	1,386	673	1,428	2,010	1,575	1,385	1,165	656
May	1,373	1,738	1,687	1,218	1,281	710	1,541	1,761	1,962	1,746	1,415	727
Jun	886	1,527	1,084	610	418	331	922	1,592	1,084	665	449	348
Jul	597	1,031	489	447	397	335	619	1,100	490	452	402	337
Aug	560	929	476	421	387	345	565	933	476	423	387	362
Sep	588	1,019	502	413	395	324	593	1,023	502	417	395	343

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	862	892	876	899	984	673	864	888	877	903	995	675
Nov	412	429	585	341	345	325	412	428	587	341	345	326
Dec	451	512	727	331	317	289	458	538	725	331	317	290
Jan	635	952	843	419	406	313	632	953	844	419	406	297
Feb	793	1,210	905	533	520	490	758	1,183	896	501	468	427
Mar	1,130	2,042	1,208	645	559	541	1,038	2,026	1,238	633	318	272
Apr	1,581	2,055	1,940	1,668	1,321	653	1,428	2,010	1,575	1,385	1,165	656
May	1,317	1,765	1,585	1,124	1,179	644	1,541	1,761	1,962	1,746	1,415	727
Jun	890	1,564	1,039	618	418	333	922	1,592	1,084	665	449	348
Jul	610	1,079	488	447	397	336	619	1,100	490	452	402	337
Aug	562	933	475	421	387	349	565	933	476	423	387	362
Sep	588	1,019	502	413	395	324	593	1,023	502	417	395	343

RPA Scenario 4

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,063	1,108	1,057	1,104	1,171	880	1,077	1,144	1,058	1,115	1,183	878
Nov	485	491	602	426	458	427	484	492	603	426	458	421
Dec	485	560	716	350	378	336	489	578	717	350	378	331
Jan	639	943	844	426	404	344	636	948	844	427	404	320
Feb	804	1,121	897	580	594	590	773	1,120	888	533	542	519
Mar	1,405	2,117	1,314	993	1,008	1,083	1,327	2,104	1,418	981	767	809
Apr	2,619	2,672	2,831	3,009	2,738	1,914	2,418	2,603	2,475	2,546	2,494	1,918
May	2,768	3,151	3,125	2,624	2,770	1,950	2,906	3,099	3,430	3,070	2,897	1,964
Jun	2,183	2,929	2,359	1,893	1,763	1,464	2,220	2,939	2,441	1,958	1,794	1,480
Jul	2,019	2,570	2,009	1,846	1,812	1,512	2,044	2,633	2,020	1,856	1,820	1,521
Aug	1,869	2,343	1,888	1,748	1,690	1,385	1,904	2,411	1,895	1,752	1,692	1,447
Sep	1,296	1,780	1,243	1,141	1,048	949	1,313	1,789	1,286	1,135	1,057	980

RPA Scenario 4

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	850	875	876	852	984	676	861	902	876	863	995	672
Nov	411	427	585	341	345	325	410	427	585	341	345	319
Dec	445	495	723	331	317	288	450	513	725	331	317	283
Jan	634	951	842	414	405	313	631	956	843	414	406	288
Feb	786	1,185	905	534	521	490	755	1,185	896	487	468	419
Mar	1,111	2,029	1,135	645	559	540	1,034	2,016	1,238	633	318	265
Apr	1,680	2,087	1,992	1,849	1,538	738	1,478	2,015	1,635	1,381	1,297	738
May	1,442	1,802	1,705	1,322	1,400	770	1,578	1,748	2,002	1,775	1,521	785
Jun	863	1,504	1,004	610	418	331	898	1,512	1,084	665	447	348
Jul	581	984	486	447	397	329	602	1,043	490	452	402	337
Aug	540	864	474	421	387	340	564	929	476	423	387	361
Sep	588	1,023	496	413	395	324	591	1,019	502	417	395	337

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	850	875	876	852	984	676	861	902	876	863	995	672
Nov	411	427	585	341	345	325	410	427	585	341	345	319
Dec	445	495	723	331	317	288	450	513	725	331	317	283
Jan	634	951	842	414	405	313	631	956	843	414	406	288
Feb	786	1,185	905	534	521	490	755	1,185	896	487	468	419
Mar	1,111	2,029	1,135	645	559	540	1,034	2,016	1,238	633	318	265
Apr	1,680	2,087	1,992	1,849	1,538	738	1,478	2,015	1,635	1,381	1,297	738
May	1,442	1,802	1,705	1,322	1,400	770	1,578	1,748	2,002	1,775	1,521	785
Jun	863	1,504	1,004	610	418	331	898	1,512	1,084	665	447	348
Jul	581	984	486	447	397	329	602	1,043	490	452	402	337
Aug	540	864	474	421	387	340	564	929	476	423	387	361
Sep	588	1,023	496	413	395	324	591	1,019	502	417	395	337

RPA Scenario 5

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,068	1,127	1,016	1,131	1,211	865	1,085	1,139	1,048	1,135	1,212	899
Nov	533	541	641	488	503	472	534	542	643	488	503	475
Dec	486	517	696	393	402	372	492	512	738	393	402	370
Jan	610	859	843	391	400	353	610	860	857	391	400	338
Feb	713	828	859	553	589	623	693	864	860	506	528	555
Mar	1,323	1,831	1,219	1,019	1,034	1,149	1,231	1,901	1,199	918	804	860
Apr	2,459	2,517	2,691	2,679	2,493	1,934	2,277	2,463	2,318	2,328	2,244	1,941
May	2,723	3,072	3,042	2,620	2,676	2,003	2,870	3,057	3,333	2,946	2,850	2,079
Jun	2,324	2,914	2,507	2,208	2,057	1,564	2,359	2,902	2,558	2,219	2,076	1,690
Jul	2,197	2,590	2,259	2,198	2,144	1,586	2,221	2,603	2,260	2,200	2,166	1,670
Aug	1,996	2,342	2,088	2,020	1,941	1,412	2,002	2,342	2,088	2,020	1,941	1,440
Sep	1,344	1,681	1,362	1,292	1,208	975	1,357	1,708	1,396	1,293	1,196	974

RPA Scenario 5

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	776	810	783	791	933	578	792	823	816	791	933	606
Nov	394	414	564	334	321	303	395	414	564	334	321	305
Dec	399	407	660	323	294	271	405	402	702	323	294	269
Jan	570	836	811	343	366	281	570	837	824	343	366	266
Feb	661	860	837	473	483	484	641	896	838	427	421	416
Mar	986	1,705	1,006	633	540	538	894	1,775	986	532	310	249
Apr	1,440	1,887	1,798	1,444	1,173	627	1,254	1,833	1,425	1,092	924	617
May	1,231	1,638	1,466	1,122	1,070	606	1,375	1,622	1,757	1,448	1,230	683
Jun	789	1,362	916	601	408	264	810	1,350	967	612	427	314
Jul	530	860	478	447	397	263	539	873	479	449	402	284
Aug	489	735	467	421	380	287	489	735	467	421	380	288
Sep	519	827	487	413	391	278	523	841	487	413	391	281

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	776	810	783	791	933	578	792	823	816	791	933	606
Nov	394	414	564	334	321	303	395	414	564	334	321	305
Dec	399	407	660	323	294	271	405	402	702	323	294	269
Jan	570	836	811	343	366	281	570	837	824	343	366	266
Feb	661	860	837	473	483	484	641	896	838	427	421	416
Mar	986	1,705	1,006	633	540	538	894	1,775	986	532	310	249
Apr	1,440	1,887	1,798	1,444	1,173	627	1,254	1,833	1,425	1,092	924	617
May	1,231	1,638	1,466	1,122	1,070	606	1,375	1,622	1,757	1,448	1,230	683
Jun	789	1,362	916	601	408	264	810	1,350	967	612	427	314
Jul	530	860	478	447	397	263	539	873	479	449	402	284
Aug	489	735	467	421	380	287	489	735	467	421	380	288
Sep	519	827	487	413	391	278	523	841	487	413	391	281

RPA Scenario 6

Stanislaus River Immediately Upstream From Goodwin Dam

Chinook Salmon Spawning (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

Chinook Salmon Egg Incubation and Fry Rearing (Target Flow = 300 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	1,064	1,120	1,016	1,134	1,197	864	1,077	1,130	1,045	1,137	1,211	874
Nov	530	537	641	488	503	466	533	542	642	488	503	474
Dec	487	525	695	393	402	366	484	512	696	393	402	369
Jan	604	859	816	391	398	349	605	859	836	391	400	332
Feb	726	896	859	553	589	591	697	879	859	506	528	555
Mar	1,278	1,762	1,097	1,019	1,034	1,144	1,196	1,834	1,126	918	804	855
Apr	2,534	2,532	2,789	2,723	2,706	1,990	2,347	2,486	2,393	2,441	2,406	1,970
May	2,769	3,092	3,114	2,628	2,833	2,002	2,914	3,087	3,335	3,033	2,947	2,108
Jun	2,286	2,878	2,446	2,189	2,044	1,515	2,342	2,894	2,512	2,210	2,057	1,683
Jul	2,186	2,556	2,256	2,198	2,144	1,586	2,207	2,597	2,258	2,200	2,168	1,610
Aug	1,995	2,337	2,086	2,020	1,941	1,412	2,000	2,342	2,087	2,020	1,941	1,433
Sep	1,337	1,676	1,356	1,301	1,187	963	1,355	1,693	1,393	1,294	1,192	990

RPA Scenario 6

Stanislaus River Upstream from the San Joaquin River

Chinook Salmon Juvenile Rearing (Target Flow = 200 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	773	807	782	791	920	578	783	814	812	791	933	577
Nov	393	410	563	334	321	302	394	414	564	334	321	304
Dec	401	416	659	323	294	270	397	402	660	323	294	268
Jan	565	836	784	343	365	281	565	836	804	343	366	260
Feb	675	927	837	473	482	456	646	911	838	427	421	416
Mar	942	1,636	884	633	540	538	859	1,708	914	532	310	244
Apr	1,504	1,902	1,890	1,470	1,356	669	1,315	1,855	1,492	1,186	1,056	645
May	1,284	1,652	1,536	1,135	1,241	636	1,422	1,647	1,755	1,544	1,342	717
Jun	767	1,331	863	593	408	259	802	1,350	933	612	423	314
Jul	520	826	475	447	397	263	533	867	477	449	402	264
Aug	487	730	465	421	380	287	489	735	466	421	380	288
Sep	514	821	481	413	391	268	519	827	483	413	391	281

Chinook Salmon Juvenile Migration (Target Flow = 2,000 cfs)

	Baseline Condition						Proposed Action					
	All	Wet	Above Normal	Below Normal	Dry	Critical	All	Wet	Above Normal	Below Normal	Dry	Critical
Oct	773	807	782	791	920	578	783	814	812	791	933	577
Nov	393	410	563	334	321	302	394	414	564	334	321	304
Dec	401	416	659	323	294	270	397	402	660	323	294	268
Jan	565	836	784	343	365	281	565	836	804	343	366	260
Feb	675	927	837	473	482	456	646	911	838	427	421	416
Mar	942	1,636	884	633	540	538	859	1,708	914	532	310	244
Apr	1,504	1,902	1,890	1,470	1,356	669	1,315	1,855	1,492	1,186	1,056	645
May	1,284	1,652	1,536	1,135	1,241	636	1,422	1,647	1,755	1,544	1,342	717
Jun	767	1,331	863	593	408	259	802	1,350	933	612	423	314
Jul	520	826	475	447	397	263	533	867	477	449	402	264
Aug	487	730	465	421	380	287	489	735	466	421	380	288
Sep	514	821	481	413	391	268	519	827	483	413	391	281

Appendix C

Central Valley Steelhead (*Oncorhynchus mykiss*) Monitoring Plan for the San Joaquin River Restoration Program

Programmatic Biological Assessment

SAN JOAQUIN RIVER
RESTORATION PROGRAM

November 2011

Reclamation is currently implementing the attached Central Valley Steelhead (*Oncorhynchus mykiss*) Monitoring Plan for the San Joaquin River Restoration Program *in coordination with National Marine Fisheries Service as part of the Water Year 2012 Interim Flows Program. As described in Chapter 3.0, "Description of Proposed Action" of the Programmatic Biological Assessment, Reclamation would continue to implement and adapt the attached plan, in coordination with National Marine Fisheries Service, until sufficient habitat and channel improvements to support salmonids are complete.*

Central Valley Steelhead (*Oncorhynchus mykiss*) Monitoring Plan for the San Joaquin River Restoration Program

Statement of Need:

Spring interim flows occurring from February 1 to June 1 could attract adult steelhead into the restoration area. Attracted steelhead would not have access to appropriate spawning habitat due to a number of impassable barriers. U.S. Department of the Interior, Bureau of Reclamation in coordination with the Fisheries Management Work Group has proposed a Steelhead Monitoring Plan to facilitate detection of steelhead on the San Joaquin River (SJR) upstream of the Merced River confluence and transport to suitable habitats downstream of the mouth of the Merced River.

Fall interim flows occurring from October 1 to December 1 could also attract adult steelhead into the restoration area if the interim flows are higher than the flows in the SJR tributaries. However, during fall interim flows, the Hills Ferry Barrier (HFB) is in place just upstream of the confluence with the Merced River and ongoing fish monitoring occurs at HFB. Steelhead that reaches the HFB could be detected and potentially trapped. In the fall of 2010, a trap was installed by the California Department of Fish and Game (CDFG) and operated by U.S. Department of the Interior, Bureau of Reclamation, Denver Technical Service Center to assess the barrier's effectiveness. Some fall-run Chinook salmon were able to pass the barrier during the 2010 interim flow period, so the effectiveness of HFB is in question (Portz et al. 2011). No steelhead were detected, however bar spacing on the trap could allow steelhead that are smaller and slimmer than salmon to escape.

Background:

In 1988, a coalition of environmental groups, led by the Natural Resources Defense Council (NRDC), filed a lawsuit challenging the renewal of long-term water service contracts between the United States and the Central Valley Project Friant Division Long-Term Contractors. After more than 18 years of litigation of this lawsuit, known as NRDC, et al. v Kirk Rodgers, et al., a Settlement was reached. On September 13, 2006, the Settling Parties, including NRDC, Friant Water Users Authority, and the U.S. Departments of the Interior and Commerce, agreed on the terms and conditions of the Settlement, which was subsequently approved by the U.S. Eastern District Court of California on October 23, 2006. The Settlement establishes two primary goals: (1) Restoration Goal – To restore and maintain fish populations in "good condition" in the mainstem 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) Water Management Goal – To reduce or avoid adverse water supply impacts on all of the Friant Division long-term contractors that may result from the Interim Flows and Restoration Flows provided for in the Settlement. These goals will require developing a fisheries management plan that implements an adaptive management approach that includes professional environmental review, review of structural modifications and designs, and technical support to provide the best quality data to define problems, prioritize actions, and increase the confidence in future decisions.

The potential routes for migratory fish such as the Central Valley (CV) steelhead (Oncorhynchus mykiss) are believed to have been historically abundant in the SJR. Although little detailed information on steelhead distribution and abundance is available (Lindley et al. 2006, McEwan 2001), they are mostly distributed higher in watersheds with large river systems than Chinook salmon (Oncorhynchus tshawytscha; Voight and Gale 1998, as cited in McEwan 2001). Therefore, steelhead may have spawned at least as far upstream as the natural barrier located at the present-day site of Mammoth Pool and the upper reaches of SJR tributaries. Modeling of potential steelhead habitat by Lindley et al. (2006) suggests that apportion of the upper SJR basin historically supported an independent steelhead population. However, much of the habitat downstream from this population's modeled distribution may have been unsuitable for rearing because of high summer water temperatures (Lindley et al. 2006). Lindley et al. (2006) concluded that suitable steelhead habitat existed historically in all major SJR tributaries, although to a lesser degree than in stream systems in the Cascades, Coast Range, and Northern Sierra Nevada. Additionally, steelhead are historically documented in the Tuolumne and Kings river systems (McEwan 2001).

Steelhead abundance and distribution in the SJR basin have substantially decreased (McEwan 2001), and steelhead have been extirpated from the restoration area due to the construction of Friant Dam. Based on their review of factors contributing to steelhead declines in the Central Valley, McEwan and Jackson (1996) concluded that basin-wide population declines were related to water development and flow management that resulted in habitat loss. Dams have blocked access to historical spawning and rearing habitat upstream, forcing steelhead to spawn and rear in the lower portion of the rivers where water temperatures are often high enough to be lethal (Yoshiyama et al. 1996, McEwan 2001, Lindley et al. 2006). However, steelhead continue to persist in low numbers in the Stanislaus, Tuolumne, and Merced river systems (McEwan 2001, Zimmerman et al. 2008). CV steelhead distinct population segment includes tributaries to the SJR that drain the western slopes of the Sierra Nevada Mountains (i.e., Mokelumne, Calaveras, Stanislaus, Tuolumne, Merced, Chowchilla, Fresno, upper San Joaquin, Kings, Kaweah, and Kern rivers, and Caliente Creek; NMFS 2009). However, CV steelhead are currently extirpated from all waters upstream of the Merced-San Joaquin river confluence (Eilers et al. 2010).

Monitoring of CV steelhead populations in the SJR and its tributaries is especially challenging due to extremely low abundance of fish. CV steelhead populations are depressed to the point where monitoring opportunities are limited because sample sizes are too low to use statistical analyses (Eilers et al. 2010), and depressed to the point that even determination of presence is difficult.

Study Site:

The Restoration Area for the San Joaquin River Restoration Program (SJRRP) includes the SJR between Friant Dam and it's confluence with the Merced River. For this study, the monitoring will be from Sack Dam to the confluence of the Merced River. Sack Dam will be the upstream extent because it is impassable in low water year types.

Five sampling methods have been developed for this proposed adult steelhead monitoring plan.

Sampling Method 1: Raft Mounted Electroshocker

Electrofishing is a common method used in monitoring steelhead population (e.g., Mill and Deer creeks, and Feather, American, Mokelumne, Stanislaus, and Merced rivers). One potential drawback for using electrofishing in rivers involves the difficulty in obtaining permits due to the possibility of injuring fish in anadromous salmonid waters (Eilers 2008). However, electrofishing effectiveness and safety have improved over time (Bonar et al. 2009). Design specifications to reduce injury to fish, and a comprehensive review of electrofishing literature can be found in Snyder (2003). Sampling frequency will be monthly from December through March of the following year. Capture of the same fish multiple times is be anticipated, thus monthly sampling is important to ensure fish recovery from stress between capture. Raft mounted electroshockers will be used in order to navigate through shallow waters of the sampling locations (i.e., Mud Slough, Salt Slough, Newman Wasteway, Eastside Bypass, Mariposa Bypass, Sand Slough Control Structure, and base of Sack Dam). Electrofishing methods would refer to the NMFS guidelines for sampling waters with anadromous fish. However, the guidelines are for backpack electrofishing, but researchers are not precluded from using other techniques or equipments as long as NMFS are given substantial proof that proposed techniques or equipments are necessary for the study and that listed species are safeguarded (NMFS 2000). Additional permitting is necessary under this method.

This option has a high potential to be successfully implemented during 2012 spring interim flows. The significant constraints to this method are permitting and access to appropriate sampling locations.

Sampling Method 2: Fyke nets with wing walls and fish traps

Migrating adult steelhead are difficult to monitor using techniques commonly used (e.g., carcass surveys, snorkel surveys, redd counts) to assess salmon populations due to their unique life-history traits. Steelhead, unlike salmon, may not die after spawning. Therefore, carcasses may not be available for a mark-recapture survey. In addition, steelhead migrate and spawn during the late-fall, winter, and spring months when rivers have periods of pulse flows (e.g., VAMP), high flows (e.g., flood releases), and turbid water conditions. A fyke net with wing walls and traps is the proposed sampling method to overcome difficulty of monitoring adult steelhead.

Fyke nets have long been used to capture migrating fish to monitor their yearly changes and abundances. This net tends to be the most useful in capturing fish that follow the shorelines at different times of the day during fish migration season. These nets are constructed of 3.7-cm mesh formed over a 1.5 m x 0.5 m rectangular lead hoop with 0.95 cm diameter solid round stock and three 1.5-m diameter hoops. The traps contain two 5 m long throats with 15 or 25 cm diameter throats, and have a zipper for easy fish removal. Wings will be 1.8 m deep and 48.8 m long. A buoy will be affixed with a 10-m length of rope. Nets will be held in place with 22-kg anchors and will be deployed in sampling locations (i.e., upstream of the confluence of the Merced River, the mouths of Mud, Slough, Salt Slough, Newman Wasteway, and existing structure at Sack Dam). This proposed technique will be implemented once the HFB is removed around mid-December and will remain deployed at the sampling locations until March 15. The traps will be checked daily so the likelihood of fish being physically injured is low. Adult steelhead that get captured will be sampled, tagged, and released. Data from this trap will give an actual count of steelhead abundance migrating in the upper reaches of the SJR.

Fyke nets will be used in lieu fyke traps for several reasons: fyke nets are relatively inexpensive and easy to install, are not a boat passage impediment (can be pushed down in the water column for boat passage), easily replaced if damaged, easy to transport, and no permitting required to transport. Although, CDFG wire fyke trap can catch fish in high flows, it will require a crane to remove the trap out of water under increased hydraulic pressure and in the event that the trap becomes silted.

Sampling Method 3: Steelhead specific trammel nets

Trammel nets are most common as stationary gear to block off channels with low velocities or no flows. However, they can also be used to drift in short durations (e.g., 20 min) on high velocity water. A short duration drifting of trammel net is necessary to prevent fish from being entangled for a long period of time. Trammel nets are advantageous and relatively efficient in turbid waters. This net consist of three parallel vertical layers of netting, the inner net has a very small mesh size, while the outer nets have mesh size large enough for fish pass. The larger and smaller mesh size nets form a pocket when fish try to swim through. Similar to seine nets, trammel nets are equipped with floats attached to the head rope and lead weights along the ground rope. For safety reasons, brightly colored floats will be used to attach to the head rope so boaters and other recreationists can avoid entangling themselves, their boats, and/or their fishing gears with the nets while floated. To ensure safety of steelhead, fisheries biologists tending the nets follow at a close distance to observe, reduce risk of entanglement, and retrieve nets in short time intervals. Sampling time will depend on the number of fish and bycatch caught at each location.

Sampling will begin during adult steelhead migration (mid-December until mid-March) on a number of habitats on the SJR where steelhead may be present. Additional permitting is necessary under this method.

Fish Handling and Relocation

For all sampling methods listed above, captured adult CV steelhead will be subject to standard handling and transporting procedures. Captured steelhead will be recorded, measured (i.e., fork length and total length), sexed (if possible), sampled for scales and tissues, and checked for injuries and presence of tags. Additionally, fish will be Floy tagged with a unique identification number to document any recaptures that may occur in the study area.

Captured steelhead would be transported downstream of the mouth of the Merced River in transport tanks following proposed transport protocols. The transport tanks will be immediately filled with river water prior to transport using a portable screened water pump. Captured steelhead will be moved in and out of the transport truck using a water-filled vessel to help minimize stress and loss of slime. Oxygen gas will be supplied to the transport tanks using compress oxygen gas cylinders and micro-bubble diffusers to maintain dissolved oxygen levels at near saturation during transport. Transport water will be supplemented with sodium chloride to decrease ionic gradient as another way to minimize stress. The truck will be stopped after 30 minutes of transportation and each hour thereafter for visual inspection of the life-support system and fish wellbeing. Water will be tempered to the receiving water at the predetermined release location before transferring fish, by pumping receiving water directly into the transport tank until the temperature reaches that of the release water.

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