Table of Contents

Tables

Figures

Abbreviations & Acronyms

AFRP	Anadromous Fish Restoration Program
AFSP	Anadromous Fish Screen Program
BA	Biological Assessment
BDCP	Bay Delta Conservation Plan
BDPAC	Bay Delta Public Advisory Committee
BO	biological opinion
CBDA	California Bay-Delta Authority
CCWD	Contra Costa Water District
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CFS	conservancy fairy shrimp
CNDDB	California Natural Diversity Database
Corps	U.S. Army Corps of Engineers
CVI	Central Valley Chinook salmon ocean harvest index
CVP	Central Valley Project
CVP	Central Valley Pumps
CVPIA	Central Valley Project Improvement Act
dB	decibels
DCC	Delta Cross Channel
Delta	Sacramento-San Joaquin Delta

Delta	Sacramento-San Joaquin River Delta
Delta	San Joaquin Delta
DFG	Department of Fish and Game
DOI	Department of the Interior
DPSs	distinct population segments
DSM2	Delta Simulation Model II
DWR	Department of Water Resources
EFH	essential fish habitat
ERP	Ecosystem Restoration Program
ESA	Endangered Species Act
EWA	Environmental Water Account
EWP	Environmental Water Program
FMPs	fishery management plans
FMWT	Fall Midwater Trawl Survey
FRFH	Feather River Fish Hatchery
GGS	Giant Garter Snake
GGS	Giant Garter Snake
HORB	Head of Old River Barrier
IEP	Interagency Ecological Program
JPE	Juvenile Production Estimates
LSNFH	Livingston Stone National Fish Hatchery
LSZ	low salinity zone
LWD	large woody debris
mm	millimeters
NMFS	National Marine Fisheries Service
NPS	non-point source
OMR	Old and Middle Rivers
PAHs	polycyclic aromatic hydrocarbons
PCE	Primary Constituent Elements
PFMC	Pacific Fishery Management Council
POD	Pelagic Organism Decline
Project	2-Gates Project
PTM	particle tracking model
RBDD	Red Bluff Diversion Dam
RM	river mile
RMA	Resource Management Associates

RPA	Reasonable and Prudent Alternative
SDTB	South Delta Temporary Barriers
SEL	sound exposure level
SKT	Spring Kodiak Trawl
SMSCG	Suisun Marsh Salinity Control Gates
SRA	shaded riverine aquatic
SWP	State Water Project
SWP	State Water Pump
SWRCB	State Water Resources Control Board
TBI	The Bay Institute
TNS	Townet Survey
USFWS	U.S. Fish and Wildlife Service
VAMP	Vernalis Adaptive Management Plan
VPFS	vernal pool fairy shrimp
VPTS	vernal pool tadpole shrimp
WAP	Water Acquisition Program
YOY	young-of-the-year

SECTION 5

Effects of the Action

5.1 OVERVIEW

In Section 2, "Project Purpose and Description," of this BA we provide an overview of the Action, its location, the gate concept, planned construction, operations, and maintenance, and planned monitoring activities along with other measures incorporated as part of the proposed project to protect listed aquatic and terrestrial species. Section 3, "Status of Species and Critical Habitat," and Section 4, "Environmental Baseline," provide an overview of listed aquatic and terrestrial species and designated critical habitat under consideration, along with their current status and a description of various factors already affecting populations both throughout their range and within the Action Area (the area anticipated to experience direct or indirect effects of the proposed project).

The following analysis focuses on those factors that are the result, directly or indirectly, of the 2-Gates Project. After a brief description of the analytical approach used in this BA, this effects analysis is organized first according to project phase (construction, operations, or monitoring), and second according to species groups (aquatic species and their critical habitat, then terrestrial species and their critical habitat).

This effects analysis is based on our current understanding of the effects of construction, operations and monitoring activities that are part of the 2-Gates Project. Construction effects are evaluated relative to changes to existing conditions at the project sites – both areas contain rip-rapped levees along both banks. Riparian habitat consists of a bed of emergent vegetation primarily tules and cattails supporting limited to little shaded riparian aquatic habitat. Connection Slough is a constructed channel. Neither channel is regularly dredged to support navigation but may be irregularly dredged to maintain or repair levees. Both sites are influenced by Delta inflow, tidal flows, in-Delta diversions and discharges and CVP and SWP water export pumping operations.

The effects analysis of 2-Gate Project operations is based on extensive modeling of hydrodynamics and delta smelt behavior. Details of these models are provided in Appendices D and E and are summarize briefly in Section 5.2.1 below. Initial results from the modeling processes indicates a decrease in the entrainment risk to adult and juvenile delta smelt and other species when the 2-Gates Project is operated in a comprehensive manner with OCAP flows. Collectively, deploying and operating the 2-Gates Project can result in increased protection for delta smelt while providing for reduced restrictions on water supplies.

5.2 APPROACH TO THE OPERATIONS ASSESSMENT

The development of the 2-Gates Project employed an iterative process of model development and use. Progressively detailed model analyses were applied to assist in site selection, project design, the development of the initial project operations plan, culminating with the effects analysis for this BA. This section generally describes the modeling process used to evaluate effects on biological resources and presents initial model results and essential findings.

It should be pointed out that the many modeling steps used differing operational assumptions and hydrology. Results from previous models were used to refine operations and improve subsequent simulations to better reflect operations under realtime conditions. This was a vailid process for transitioning from one level of study to another in an effort to refine and improve project operations. Because of this iterative process, model results should not be directly compared between models.

5.2.1 Modeling Basis for Operations

To develop the initial operations plan, Resource Management Associates (RMA) developed and refined a series of hydrodynamic model analyses, to examine expected effects from different operations scenarios. These models are summarized below, with details provided in Appendix D. If required, time series model output, including flow (cfs), stage (ft), turbidity (NTU), and salinity (as EC), are available.

5.2.1.1 Hydrodynamics and Turbidity Modeling

The models of the Delta utilize the RMA finite element models for surface waters. (Appendix B). The RMA models are a generalized hydrodynamic model that is used to compute two-dimensional depth-averaged velocity and water surface elevation (RMA2) and another model (RMA11) that is a generalized two-dimensional depth-averaged water quality model that computes a temporal and spatial description of water quality parameters. RMA11 uses stage and velocity results from RMA2. The Delta model extends from Martinez to the confluence of the American and Sacramento Rivers and to Vernalis on the San Joaquin River. Daily average flows in the model are applied for the Sacramento River, Yolo Bypass, San Joaquin River, Cosumnes River, Mokelumne River, and miscellaneous eastside flows which include Calaveras River and other minor flows.

RMA ran a set of hydrodynamic, EC, and Turbidity simulations to form the basis of the initial gate operations schedule. The modeling study evaluated how conditions change in the Delta under historical conditions, historical conditions operated under the OCAP RPAs and operated under OCAP RPAs with the Project. Historical simulations were run for the period between December and July for 1999–2000, 2002–2003, 2003-2004 and 2007–2008. These years were selected because they were the only ones with adequate data to support the analysis.

5.2.1.2 Delta Smelt Behavioral Modeling

Delta smelt distribution and entrainment was modeled with two distinct particle tracking techniques representing the adult life stage and the larval/juvenile life stages (detailed in Appendix D). RMA developed a particle behavior model to simulate the movement of pre-spawning adult delta smelt based on simulated distributions of salinity (represented as electrical conductivity, EC) and turbidity. Because turbidity is a key driver for the distribution of adult smelt, the optimum gate operation to minimize adult entrainment is based on controlling progress of the turbidity plumes from the Sacramento and San Joaquin Rivers and reducing the turbidity along Old and Middle Rivers downstream of the export facilities.

Larval and juvenile delta smelt are considered to be small enough to represent as passively transported particles. Initial evaluation of gate operations for minimizing larval and juvenile entrainment was performed by CH2M Hill. In that study, the DSM2-PTM (Delta Simulation Model II – Particle Tracking Model) was use to evaluate potential entrainment for smelt monitoring locations around the Delta. In this analysis a passive particle tracking methodology (developed by Dr. Edward Gross with Dr. Lenny Grimaldo (USBR) and Dr. Ted Sommer (DWR)) is used to represent the spatial and temporal distribution of larval and juvenile delta smelt, considering hatching rates, growth, and mortality. Hatching rates are derived through an automated tuning algorithm that develops a best fit estimate of regional hatching rates from the historic 20mm Trawl Surveys.

Both the adult and larval/juvenile particle tracking analysis utilizes the RMA Bay-Delta Model for hydrodynamics and water quality simulation and the RMA TRK particle tracking model.

5.3 CONSTRUCTION EFFECTS ON AQUATIC SPECIES

Construction activities include levee clearing of rip rap and vegetation at each shoreline at each site, dredging (clamshell dredge), dredge spoil disposal, sheet pile dike installation (vibration-driven),boat ramps, placement of rock in the channel and on levees, installation of the gate barge (the gate barge is the barge and the gate structure, control house and all wiring and electrical components that are pre-installed on the barge, then barge is then towed to the site and sunk to the prepared foundation), and removal of the gate barge and lock rock, sheet piles and boat ramps at the end of the demonstration period. Foundation preparation for the gate barge involves dredging peat material from the channel bed, estimated at 5,500 cubic yards for Connection Slough site and 7,000 cubic yards for Old River site. Dredging will be from the channel bed surface to the top of the underlying compact sand layer (believed to be at ~-32 ft ± at both sites).

Exposure of aquatic species to construction effects of the 2 Gates Project depends on the spatial and seasonal occurrence of different species and life stages within the Delta (Table 5-1). The period of in-water construction at the two sites may be up to five weeks and is scheduled for September-October 2009 for the levee preparation, installation of the sheet pile walls, boat ramps, dredging barge foundations, and the placement of foundation rock, and two weeks in November for gate barge installation. It will require about two weeks in July, at the end of the demonstration period, for removal of the gate barges, and all associated structures (e.g. sheet pile walls, boat ramps, etc.) from the Old River and the Connection Slough channels. The cavity in the bed where the barges were set will be brought up to channel bed elevations with small rock. All in-water work for the 2-Gates Project is planned to be conducted within the in-water work windows already established by the fish agencies to limit project impacts to listed salmonids (winter-run and spring-run Chinook, CV steelhead) and delta smelt. Therefore, it is anticipated that the immediate effects of construction on listed fishes will be minimal, although some individuals may still be found within the Project work areas.

Table 5-1. 2-Gates Construction Timing and Duration and Likely Occurrence of Aquatic Species and Critical Habitat at Construction Sites

Construction Activity	Timing	Duration	Species Likely Occurring at Construction Sites	Critical Habitat
Construction of sheet pile walls, dredging barge foundation, installation of barge rock base and	September- October 2009	Five weeks	CV steelhead (adult, juvenile) Green sturgeon (adult, juvenile)	Delta smelt CV Steelhead Green Sturgeon
Installation of barge with gates and anchor rock	November 2009	Two weeks	CV steelhead (adult, juvenile) -unlikely Green sturgeon (juvenile) Spring-run Chinook (juvenile possible but unlikely)	
Removal of argegates from both sites and sheet pile dikes from Old River only	July 2014	Two weeks	Green sturgeon (adult, juvenile)	

Species that could potentially occur near the sites during in-water construction in September-October include CV steelhead (early migrating adults and rearing juveniles) and green sturgeon (migrating adults, juveniles), with a low probability of winter-run Chinook (juveniles). Species that could potentially occur during gate barge installation in November include CV steelhead (migrating adults and juveniles), and green sturgeon (juveniles), with a lower probability of occurrence for spring-run Chinook (juveniles) and CV steelhead (juveniles). Species that could potentially occur near the sites during gate removal in July include green sturgeon (adults and juveniles), with a low probability of CV steelhead (juveniles still in the Delta). Adult winter-run and spring-run Chinook would not likely occur at the Project sites because they stay primarily in the Sacramento River during their upstream migration. The two construction sites on Old River and Connection Slough are located within designated critical habitat for delta smelt, CV steelhead, and green sturgeon (proposed). The existing habitat primarily functions as critical freshwater and estuarine rearing and miratory corridors for juveniles of all species and as migratory corridors for adult salmon steelhead and sturgeon.

The existing habitat quality of these leveed, riprapped Delta channels for rearing of juvenile salmonids is poor.

This assessment examines several potential effects from construction activities:

- Direct injury or mortality from dredging and placement of rock and the gate barges
- Behavioral, physiological or physical habitat changes or impairment in response to, or as a result of:
  - Underwater noise and disturbance
  - Turbidity and/or resuspension of sediments and contaminants and resettling on benthic habitats
- Alteration of benthic habitat by placement of rocks, sheet piles and the barges.

5.3.1 Direct Injury and Mortality

Construction activities include dredging, sheet pile wall installation, rock placement, gate barge installation, boat ramp installation and the removal of the gate barges and all associated structures at the end of the demonstration period. Dredging will be conducted using a bucket dredge rather than a hydraulic or suction dredge, thereby avoiding the impact most typically associated with dredging (entrainment of fish). The principal risk of direct injury and mortality to listed species would be from striking, collision or capture in the dredge bucket or crushing due to placement of rock or installation of the gate barge and sheet pile dikes (especially for bottom dwelling species such as green sturgeon). By using a bucket dredge and disposing of spoils on land, the Project will avoid other potential effects of dredging, such as fish entrainment and burial of benthic organisms and habitat by disposed sediments (Reine et al. 1989, Nightingale and Simenstad 2001, Hoover et al. 2005).

5.3.2 Noise and Disturbance

Noise associated with construction activities of the 2-Gates Project has the potential to adversely affect aquatic species. Transient noise from dredging, foundation preparation (i.e. rock placement), vibratory sheet and king pile driving, surface machinery, and topside activities on the construction barge decks during installation of the gate structures on site may have adverse effects on fish in close proximity to the noise source. This effect is expected to be localized and temporary in nature. Furthermore, these activities will occur during periods when few listed species are likely present in the area (delta smelt, green sturgeon and CV steelhead).

High levels of underwater noise can adversely affect some fish species[1]. The effects of pile driving on fish have been assessed by NMFS and others (Hastings and Popper 2005, Popper et al. 2006, Carlson et al. 2007, NMFS 2008d,). The 2-Gates Project will use a vibratory hammer to install the sheet pile dikes and king piles (wall) between the gate structure and the levee at each site (see appendix G for details). Vibratory hammers are generally much quieter than impact hammers and are routinely used on smaller piles (ICF Jones & Stokes and Illingworth & Rodkin 2009). Information is not currently available regarding transient underwater noise

[1] Three metrics are commonly used in evaluating hydroacoustic impacts on fish: peak sound pressure level (LPEAK), root mean square (RMS) sound pressure, and sound exposure level (SEL) (ICF Jones & Stokes and Illingworth & Rodkin 2009). SEL is defined as the constant sound level acting for one second, which has the same amount of acoustic energy as the original sound (Hastings and Popper 2005). Reference sound levels from pile driving normally are reported at a fixed distance of 10 meters. Underwater peak and RMS decibel levels are usually referenced to 1 micropascal (μPa), and the SEL is referenced to 1 micropascal squared per second (dB re: 1μPa^2-s). (Hastings and Popper 2005).

associated with dredging, rock placement, surface machinery and topside activities on the barge decks. However, it is not expected that these noise levels will reach the same levels as from pile driving.

Fish impacts from exposure to pile driving activities were reviewed by Hastings and Popper (2005), and recommendations provided to protect fish from physical injury (Popper et al. 2006, Carlson et al. 2007). In 2008 NMFS, USFWS and DFG adopted interim criteria of a peak sound pressure level of 208 decibels (dB) referenced to 1 µpascal per second (re: 1µPa^2-s) and a cumulative sound exposure level (SEL) of 187 dB re: 1µPa^2-s (Fisheries Hydroacoustic Working Group 2008, ICF Jones & Stokes and Illingworth & Rodkin 2009). Although these criteria were specific to impact or percussive pile driving, they have served as a general guideline for noise thresholds for the onset of physical injury in fish exposed to the impact sound associated with pile driving (NMFS 2008d).

Sheet and king pile driving is expected to generate the greatest levels of underwater noise. Rock placement is also expected to generate underwater noise. These activities may generate sharp transient noises from metal components (buckets, scoops, etc.) striking rock that will propagate into the water column. The noise will be transient, occurring over a five week period. The 2-Gates Project will use a vibratory hammer, which is quieter (ICF Jones & Stokes and Illingworth & Rodkin 2009). Although peak sound levels can be substantially less than those produced by impact hammers, the total energy imparted can be comparable to impact driving because the vibratory hammer operates continuously and requires more time to install the pile (ICF Jones & Stokes and Illingworth & Rodkin 2009). Sound levels during vibratory pile driving were measured at the City of Stockton Downtown Marina (Power Engineering 2008). Peak sound pressure levels ranged from 184 to 202 dB re: 1µPa, while accumulated SEL's ranged from 181 to 195 dB re: 1µPa^2-sec, as measured at 10 meters from the pile and mid-water depth (approximately 2 to 3 meters below the water surface). The duration of pile driving ranged approximately 6-12 minutes, with periods of 11 - 71 minutes between pile driving (Power Engineering 2008). The peak sound pressure levels were below recommended levels, while the accumulated SEL's slightly exceeded the recommended criteria by 8 dB re: 1µPa^2·sec. It is anticipated that pile driving associated with the 2-Gates Project would have similar results in terms of SEL and peak sound pressure levels. During the 5-week period of observing each pile installation, technicians did not observe effects on salmonids or other species related to the pile installations. It is anticipated that pile driving associated with the 2-Gates Project would have similar results in terms of SEL and peak sound pressure levels and effects on aquatic species. This combined with the relatively short duration expected to drive each king pile and sheet pile along with an anticipated period between pile driving, and the timing of work within established in-water work windows suggest that physical injury to fish is unlikely.

Anticipated responses of any fish within the work area would more likely be behavioral in nature (startle response, avoidance etc.), although these would diminish with distance from the construction sites. Hastings and Popper (2005) concluded that data are lacking on behavioral responses to pile driving, such as a startle response to noise or movement away from highly utilized habitats impacted by sound. Carlson et al. (2001 cited in NMFS 2008c) reported migrating juvenile salmon reacting with startle behavior in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators.

5.3.3 Turbidity and Resuspension of Sediments

The main impact from construction is likely to be resuspension of channel sediments during in-channel activities. Site preparation in September and October includes dredging, followed by pile driving and installation of the sheet pile dike and rock placement. In November, the barge with gate will be installed and lock rock placed. Sediments resuspended during dredging operations pose a variety of water quality and ecological concerns (Nightingale and Simenstad 2001, Bridges et al. 2008, Newcombe and MacDonald 1991) ranging from lethal to sublethal to behavioral. The turbidity plume in the immediate vicinity of a dredging operation could influence the behavior or health, and to a lesser degree growth, of fish and other organisms such as aquatic macroinvertebrates. Young and Mackie (1991) found that benthic macroinvertebrates inhabiting the upper surface of the substrate may be more adaptable to sedimentation than are taxa occupying the interstitial spaces of the substrates. The background conditions of fine sediment and peat suggests that the benthos is conditioned to turbid environments and resuspension and eventual resettling of fines should have minimal impacts to that resource. The change from background levels, the type of suspended sediment, its concentration and duration, and species and life stage of fish are all factors to consider in evaluating the effect of exposure (Newcombe and Jensen 1996). Some effects that could occur in the Delta include avoidance of a turbidity plume and altered foraging and predation dynamics.

Foundation preparation for the gate barge consists of dredging peat material estimated at 5,500 cubic yards for Connection Slough and 7,000 cubic yards for Old River. Dredging the peat sediment, which are rich in fulvic and humic acids, is expected to release a combination of organic and inorganic sediments into the water column, with associated potential reductions in dissolved oxygen. Barrier construction activities would increase localized turbidity at the two project sites that would extend downcurrent from the installation site due to tidal flow. Although this increase in turbidity may affect fish by inducing avoidance of the plume, temporarily disrupting feeding, or disrupting resting or movement behavior, green sturgeon and steelhead are strong swimmers capable of moving away from the area of disturbance. Peat also provides an effective filtering function and its instream role of filtering would be transferred to the remaining peat bottom.

These effects would be limited in scope, due to the relatively small construction area and limited duration of construction. Once in-water construction stops, water quality is expected to return to background levels within a few hours, depending on hydrodynamics and the amount and size of fines in the channel sediments. The potential for exposure is therefore limited to those fish that may be present during the construction season (green sturgeon and juvenile steelhead) and they would avoid adverse conditions.

In-water construction activities also have the potential to distribute sediment-borne contaminants, if present, into the water column and onto nearby substrate, where they could be taken up by benthic organisms. Resuspension of contaminated sediments could have adverse effects on fishes that encounter the sediment plume, even at low turbidity levels. These effects will be localized and temporary, although some effects could persist if the mobilized sediments are contaminated and enter the benthic food chain. Contaminant mobilization, contaminant leaching, bioaccumulation, and trophic transfer through the food web can occur during or as a result of the dredging (Bridges et al. 2008). Green sturgeon could be affected because they are benthic foragers and can bioaccumulate contaminants over their long lifespan. The potential for this effect is related to the degree of contaminants in the sediments to be dredged and the total area disturbed. It is not known whether contaminated sediments are present at the two construction sites.

Construction vessels could potentially release contaminants into the water column due to runoff of oil-based materials during operations. This could affect fish through impaired water quality and substrate quality. Surface contaminants would be addressed in a Spill and Pollution Prevention Plan, which will outline actions to reduce impacts from this activity and address responses to potential spills. The implementation of BMPs and other protection measures would mitigate the potential effects on fishes and their habitat.

5.3.4 Altered Physical Habitat

Installation of the rock foundation and the barges would directly affect a total of about 70,000 square feet (approximately 1.6 acre) of total channel bottom within the Delta. The amount at each site is approximately 33,200 square feet (0.76 acre) at the Old River site and approximately 36,750 square feet (0.84 acre) at the Connection Slough site.

This action would replace soft bottom habitat of peat and mud with rocky bottom habitat, resulting from the rock locking fill, and two solid deck barges. As a result, the benthic community structure will be altered within the footprint of the gate structures. Species adapted to the soft peat and mud habitat will be replaced, in these particular areas, with those more adapted to firm rock and/or solid bottom surfaces. This alteration or reduction of the benthic community could potentially change the foraging habitat for green sturgeon potentially occupying the area. Data is lacking regarding the occurrence of green sturgeon within the project sites although juvenile green sturgeon are collected at the CVP and SWP fish facilities so, by inference, some of these fish must pass by the gate structures. The alteration of physical habitat at the gate sites within the channels of Old River and Connection Slough would not be expected to adversely affect the pelagic feeding habitat of delta smelt.

The gate structures would likely attract predatory fish, thereby increasing predation risk for delta smelt and juvenile salmonids occupying the area. The predation risk for green sturgeon is not expected to be increased much because of their large size (juveniles 200-500 mm) and protective scutes (NMFS 2009). Gate structure installation would also alter near field channel hydraulics changing the channel from mostly laminar flow to locally turbulent flow conditions around the gate structures during portions of the tidal stage (Appendix E). This change would be most notable at the Old River site, where a larger volume of tidally driven water passes during each tidal cycle.

The Old River and Connection Slough sites are within the designated critical habitat for delta smelt, CV steelhead, and green sturgeon. Installation of the gates would affect certain PCE's for these species. For delta smelt, this would affect the PCE for Physical Habitat including spawning substrate. The scale of any potential impact is discountable to low, however, given the relatively small footprint of the Project on the substrate. For CV steelhead juveniles, the quality of freshwater rearing habitat is affected by reduction in habitat complexity and food supply that would be provided by the benthic environment, and by the potential for fish predators to have an attraction to the Project's structure and altered hydraulics. For illustrative purposes, the area of channel bottom in Old River alone was estimated at roughly 1,200 acres[2]. The gate structures and fill represent less than 0.15% of the channel bottom in Old River alone. For CV steelhead juveniles, the quality of freshwater rearing habitat is affected by habitat complexity, food supply, and presence of fish predators. The baseline condition of freshwater rearing habitat within Delta channels, however, is already degraded, and installation of the Project would not measurably exacerbate this degradation. For green sturgeon juveniles and adults, attributes of tidal freshwater habitat that would be altered are principally benthic foraging habitat. However, as mentioned above, the overall amount of habitat altered is small relative to what is available in the Delta, so the action is not likely to adversely affect the prey base for green sturgeon or juvenile salmon populations.

Migratory corridors for emigrating CV steelhead juveniles and for green sturgeon adults and juveniles through Old River and Connection Slough are not expected to be substantially blocked by the gate structures. The barge deck and lock rock along the barge sides will be flush with the bottom, leaving a full-depth channel open through the gates. Although green sturgeon are benthic foragers, telemetry studies of adults and subadults in San Pablo Bay documented sturgeon swimming closer to the surface when moving directionally (Kelly et al. 2007).

Construction on the levees would disturb existing emergent or riparian vegetation and habitat resulting in reduced shoreline vegetation and any riparian function it may have in supporting juvenile Chinook that utilize the area. Reductions in functions may include loss of shading and stabilization of sediments and loss of insect prey items for juvenile Chinook (Toft et al. 2004). However, the existing riparian function is already degraded and very small in relation to what is available in the Delta. In conclusion, the Project construction would not have a significant effect on the physical habitat for the listed aquatic species.

---

[2] Estimate for Old River based on a 17 mile long channel from Franks Tract to the Skinner Fish Facility, and 600 foot average channel width. The channel is 800 feet wide at the site of the Old River gate.

5.4 OPERATIONS EFFECTS ON AQUATIC SPECIES

The gate structures and their operations will have several effects on listed aquatic species including changes to physical habitat, flow patterns, and increased risk of predation. Changes to physical habitat conditions result from installation of rock, gate barges, sheet pile walls and boat ramps. Structures change physical habitat conditions in a channel cross section that was primarily composed of open water channel with a soft sediment bed and bordered with a shoreline of tule-fringed rip-rapped levees on either side. The otherwise open water habitat of the channel is occupied by steel sheet pile walls that extend from the bed to above the surface creating vertical walls with little habitat value. Water velocities are low near the wall and slow eddies may develop in the backwater areas between the gate and levee. The barges will be set into the bed of each channel such that the top deck will be at most a couple of feet above the channel bed. This will minimize restrictions to channel cross sections and avoid any shoaling effect from the barges. The deck of the steel barge provides poor quality bottom habitat with limited complexity to support invertebrates. Piles and decks for the boat ramps create structure in the nearshore area and can also provide shade, but the use of the boat ramps would disturb fish using these areas. These areas may provide habitat for predators, both fish and birds. The interstices in the rocks used to lock the barge in place provide habitat elements along both bank slopes and barge ends. This can provide habitat for crayfish, catfish or other aquatic cavity dwellers.

Gate installation and operation will create structure within the channels and favorable conditions that are anticipated to attract predatory fish. In addition, the gate structures will change the flow field in close proximity to the barges. The constrained channel cross section will change the mostly laminar flow of these channels to areas of turbulent flow during large tidal changes when water accelerates from the high side of the structure through the gate to the low side. These higher velocity zones will create eddies and shear zones along their sides that predator fish can use to feed on smaller fish being swept along with the current. Predatory fish in the Delta (primarily striped bass, largemouth bass, sunfishes and catfish) are good at exploiting situations where food is abundant or where features exist that enhance feeding opportunities, such as crevices or turbulent flows. For example, large populations of striped bass occur inside Clifton Court Forebay and schools of striped bass are known to occur in the vicinity of the release sites within the Delta used by the CVP and SWP salvage facilities. The gate assembly will include structures (sheet pile walls, barges, lock rock and boat ramps) that would provide interstitial spaces, topographic features or currents that can be used by predatory fish.

In Willamette River studies (Friesen 2005), described predator-habitat relationships and their effect on salmonid populations appeared minimal, even around structures and pilings. Although warmwater predators readily associated with the rip-rap habitats the study suggess that juvenile salmonids were not a dominant prey. Functioning as slough type habitat as opposed to flow-through habitat during gate closures; however, may cause the fish to congregate and be more susceptible to predation.

Navigation requirements and operation of the boat ramps and gates on a 24 hours/7 days a week requirement means that safety lighting will be installed at the gates. Flood lights will be needed to illuminate the gates, sheet pile walls and boat ramps. Lighting may attract fish into lighted areas. Night predators such herons, other birds and raccoons may also take the opportunity to use the light sources as a means of gathering food. Predators that are attracted to the gate may result in the loss of individual delta smelt, salmon or CV steelhead. The overall effect of the gate structures on predator populations in Old River and Connection Slough is not expected to result in population level effects to these listed species. To assess the affects of predatory fish on listed fish species, the 2 Gates Project Monitoring Plan will employ available video and fish finding technology to document the accumulation of predatory fish at the gate structures (see Appendix C – Monitoring Pan). In the event that predatory populations become too large at the gate sites appropriate actions (i.e. electrofishing, gill netting, angling) will be taken to reduce their numbers.

When the gates are closed, the channel ends next to the gate will function much like a dead end slough, and water quality conditions may slightly degrade with lower dissolved oxygen, change in salinity and debris ond water hyacinth mats may build up. However, these conditions would be transient and would dissipate upon gate opening. The degree to which these conditions may occur are likely closely linked to the duration of gate closure (see Table 2-2). As planned the gates will be closed up to two hours per day from December into March. During March the Old River gate will be closed on flood tides (twice daily, for up to 10 hours total), and opened on ebb and slack tides. The Connection Slough gates will be closed except during slack tide (approximately 4 hours daily). From April 1 through May 31, both the Old River and Connection Slough gates will be fully open in coordination with San Joaquin River inflow versus water export criteria established in the 2009 NMFS OCAP BO (see Action IV.2.1 at NMFS 2009). During June, both gates will be closed on flood tides and opened on ebb and slack tides. Gates will be open on weekends for recreational boating.

Modeling indicates that Project operations will predominately affect hydrodynamics in the Old River, Connection Slough and Middle River Channels. The following discussion of operational effects of the 2 Gates Project on listed fish species is based on hydrodynamic and delta smelt behavioral simulations conducted for these analyses. Details of the hydrodynamic and delta smelt behavioral simulation efforts used were briefly summarized in Section 5.2.1 and are provided in more detail in Appendix D and E. Results from the modeling indicate a decrease in the entrainment of adult delta smelt by the export facilities by controlling the distribution of turbidity that are correlated with migration of pre-spawning adults into the central and south Delta. Results from the simulations also indicate a decrease in the entrainment of larval and juvenile delta smelt over OCAP required OMR flows by operation of the 2-Gates consistent with OCAP flows and management of San Joaquin River flows resulting in net flow to the west from the central Delta.

5.4.1 Potential Effects to Delta Smelt

Based on results of hydrodynamic and behavioral modeling, the 2 Gates Project will benefit delta smelt by limiting pre-spawning adults from moving south of the gates, and thus reducing entrainment of adults and larvae from the export facilities. Because fish entering the south Delta are highly vulnerable to entrainment at the CVP and SWP pumping facilities, and are subject to increased predation and poor habitat conditions, any mechanisim which limits their movement into this area is potentially beneficial. Reproductive success in the San Joaquin portion of the Delta is reduced because many adults and most larvae have been entrained and lost during transport to and from spawning sites to rearing areas (USFWS 2008). The adult delta smelt prevented from entering the south Delta would need to find other areas to spawn, but they and their progeny would be less vulnerable to entrainment, predation and poor habitat conditions.

The following sections discuss the Project effects in further detail by life history stages and critical habitat PCEs. During the December to June gate operation period, all life stages of delta smelt may be present in the vicinity of the Project facilities. Adults would predominate in December into March, and other life stages would increase in abundance from March through June. Most adults die after spawning, so their numbers would tend to decrease after the peak of spawning (usually by April or May). Juveniles would increase in abundance through June. Historically, salvage densities for juvenile delta smelt have been highest during May and June. In wet years spawning and migration tend to occur further west in the Delta than in dry years when delta smelt migrate further up the rivers to access freshwater spawning habitat. This pattern implies that direct and indirect effects and operations may be greater in dry years than in wet years.

5.4.1.1 Life History Stages

MIGRATING AND SPAWNING ADULTS (~DECEMBER THROUGH MARCH)

Adult smelt begin moving inland from the western Delta when first flush flows increase turbidity (greater than or equal to 12 NTUs) and decrease salinity. When the higher turbidity in the west or central Delta bridges the gap through Old and Middle rivers, this links with the high turbidity waters in close proximity to the pumps. Once the turbidity bridge occurs, adult delta smelt tend to move more easily into the south Delta. Recent estimates of annual entrainment have ranged from 10 to 60 percent of the delta smelt population (adults and progeny combined) per year from 2002 to 2006 (Kimmerer 2008). Since most adult entrainment occurs between mid-December and March, the gates will be operated during this period to modulate flows in Old and Middle Rivers and thus manage distribution of higher turbidity conditions that cue adult pre-spawning migration from extending into the south Delta. The results from RMA's delta smelt behavioral simulations indicate that installation and operation of the 2 Gates Project could manage water quality to keep adults far enough north to avoid becoming entrained by the CVP/SWP pumping facilities. Figure 5-1 shows the simulated distribution of adult delta smelt for historic conditions and for different operational scenarios modeled from hydrodynamic conditons leading up to January 16, 2003. Under historic operations (Figure 5-1, upper left frame), delta smelt are distributed throughout the south Delta as well as other channels and exposed to export at the export facilities. The Lower Bound OCAP operations (Figure 5-1, lower left frame) also show delta smelt dispersing into the south Delta channels but not as extensively as under historic conditions. Simulations of OCAP Lower Bounds with 2-Gates reveal that delta smelt distribution extends only to about Woodward Canal (Figure 5-1, upper right frame). Thus the Project would limit the distribution of adult delta smelt from extending further south in Old and Middle Rivers toward the south Delta channels and the CVP/SWP pumps, thereby reducing entrainment risk.

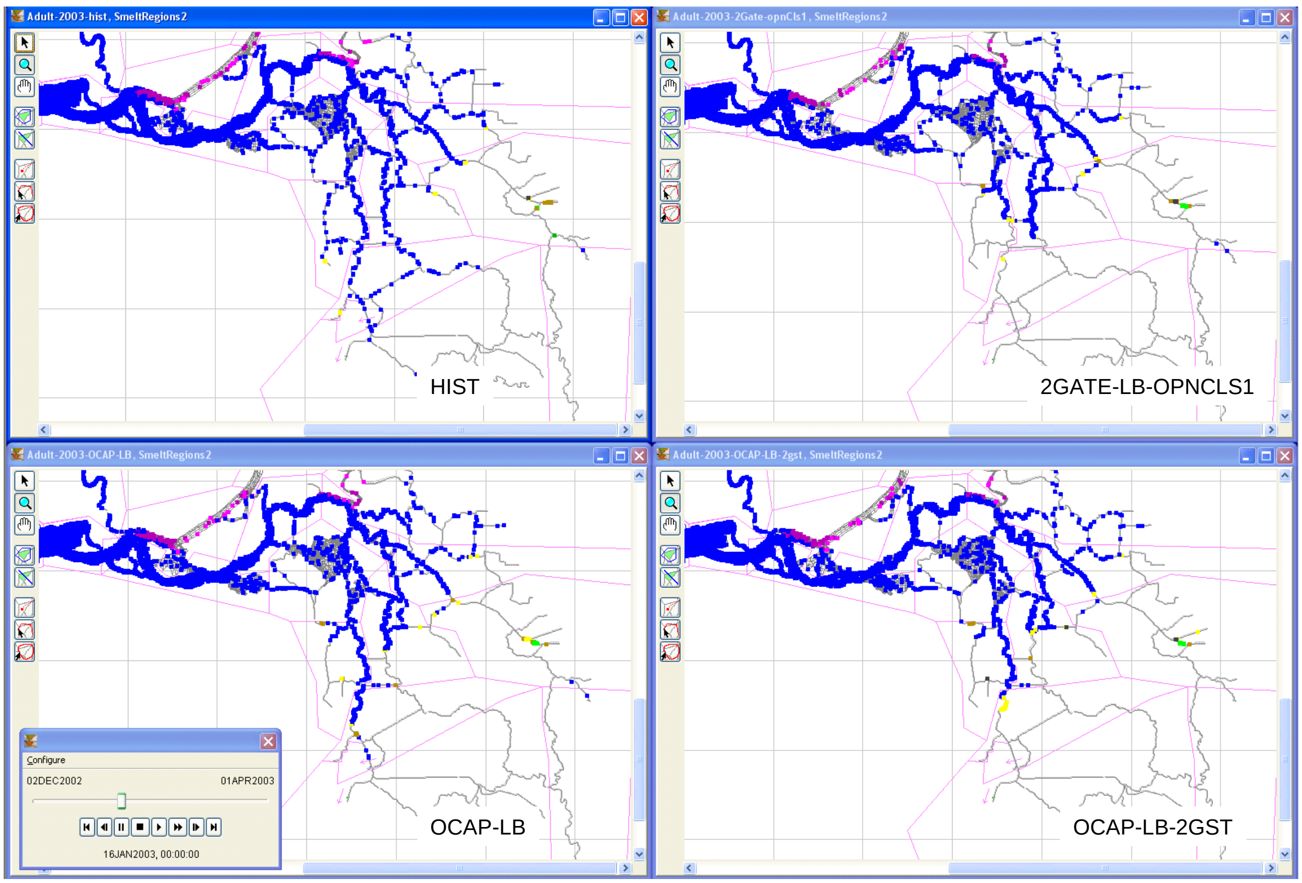

Figure 5-1. Adult Delta Smelt Particle Distributions for historical conditions (HIST), OCAP operations (OCAP-LB), and 2-Gates scenario (2GATE_LB-OPNCLS1). The difference between OCAP and OCAP with 2-GATE is the comparison of lower left with upper right figures.

LARVAL AND JUVENILE DELTA SMELT TRANSPORT (~MARCH THROUGH JUNE)

Delta smelt spawning typically commences once Delta-wide average water temperatures reach 12ºC, which occurs sometime within February or March. Once this occurs, gates will be operated to protect larval and juvenile delta smelt from entrainment into the south Delta. In March and in June, the Old River gate will be operated tidally: open on ebb tides and closed on flood tides. The Connection Slough gate will be closed, except when opened during slack tide (an hour per opening, four times per 25 hour tidal cycle) or for recreational boating on weekends in June. Gate operations will occur in combination with OCAP flows. During April and May gates will be open during the San Joaquin River inflow/export flow period.

The Project is expected to benefit delta smelt by reducing entrainment of adults, larvae and juveniles. As discussed above, operations will affect the distribution of turbidity and salinity, which would result in redistribution of pre-spawning adult delta smelt in the inner Delta and consequently would change the distribution of larval and juvenile delta smelt. The gate operations will influence habitat conditions by affecting hydrodynamics in the Central Delta.

Model runs indicate that operations of the 2-Gate Project combined with OCAP OMR flows result in better reduction in the entrainment of delta smelt than OCAP OMR flows alone (Figure 5-1). RMA's behavioral simulation shows a net decrease in the entrainment of larval/juvenile delta smelt when the Project is operated and OMR flows are balanced. Figure 5-2 compares modeled entrainment rates at the SWP and CVP facilities under various scenarios (historic, upper and lower bound OMR flows, and Project operations with upper and lower bound OMR flows).

Project operations create a dispersive mixing and that tidally pumps water south up Middle River and north up Old River, while not changing net flows in the Old and Middle River channels. This effectively places more particles in the area of Frank's Tract where they are then exposed to tidal action and pumped out of the Delta through False River. This effectively reduces the number of larval and juvenile fish being drawn into the south Delta. The gates will remain open during April and May when the San Joaquin River inflow/export ratio is in effect.

JUVENILE REARING AND ADULT DEVELOPMENT (~JULY THROUGH DECEMBER)

Delta smelt move toward the western Delta and into Suisun Bay during later spring/early summer and are generally absent from the Delta during the warm summer months. They remain in the western Delta and Suisun Bay until early winter when they begin moving back inland as adults. The Old River and Connection Slough Gates will not be operated from July to December when smelt are generally absent from the Delta. No adverse effects are anticipated during the juvenile rearing and adult development period.

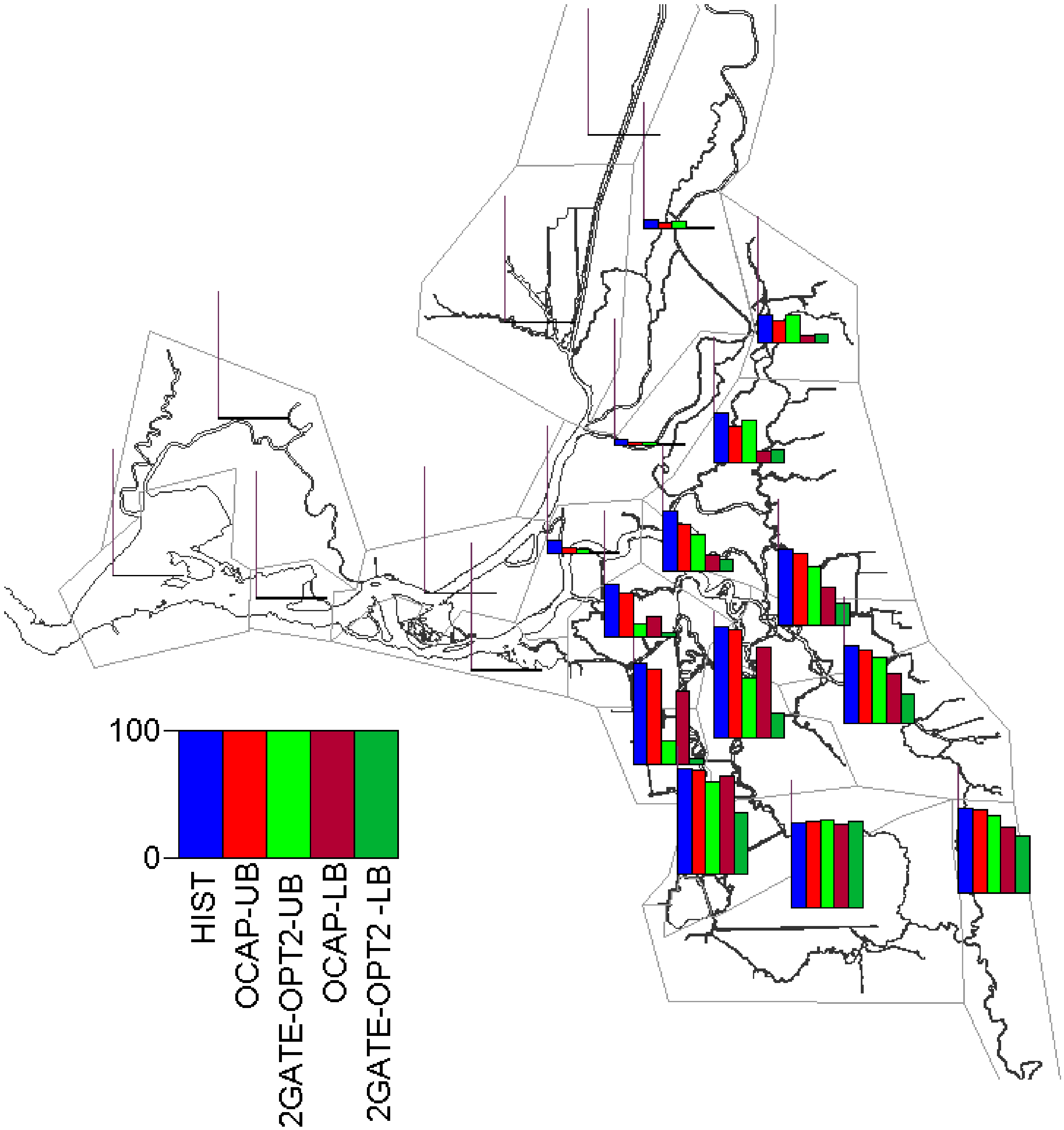

Figure 5-2. Percent of Particles Entrained at CVP+SWP). by Region during the Modeled Period under different scenarios (historic conditions, OCAP Upper Bound, OCAP Lower Bound, 2-Gates Operations with OCAP Upper Bound, 2-Gates Operations with OCAP Lower Bound).

5.4.1.2 Effects on Critical Habitat

The Project will enhance overall designated critical habitat for delta smelt. The Primary Constituent Elements (PCEs) include physical habitat (PCE#1), water (PCE#2), river flow (PCE#3) and salinity (PCE#4) and are discussed here for all life history stages. Adequate flow (PCE#3) and suitable water conditions (PCE#2) may need to be maintained to attract migrating adults in the Sacramento and San Joaquin River channels and their tributaries. Use of south Delta habitat would be reduced by the Project operations. While the south Delta is encompassed within the designated critical habitat, the condition of several PCEs (#2 water and #3 flow) have been degraded by SWP/CVP operations that have altered river flows and increased entrainment risk (USFWS 2008). Under current conditions, a significant proportion of progeny produced in the south Delta are probably entrained at the pumping facilities. While this area may have historically been used for spawning, it is believed that the south Delta is not currently an important source for production of delta smelt. Shifting spawning activity away from the south Delta to other areas where the progeny are more likely to survive would reduce the negative effects and could benefit the species. Adult smelt would still be able to access the lower San Joaquin River and other areas of the central and northern Delta by migrating up the main stem of the San Joaquin River.

The Project has a minor effect on physical habitat (PCE#1) by the placement of the gate structures in Old River and Connection Slough. About 1.6 acres of habitat is changed by the dredging, barge placement, lock rock, sheet pile wall installation and boat ramps, but delta smelt are open water species and are not known to frequent shoreline areas or channel beds except during spawning. Most of the habitat changes to the physical habitat occur at the bed of the channel or along the shoreline so would have minimal effect on delta smelt. The 1.6 acres at the two project sites make up a very small percentage of the entire channel area used by Delta smelt. The change to the physical habitat PCE is inconsequential given the small footprint of the Project structures on physical habitat available in the Delta.

PCE #2 is water for all life stages of delta smelt. The condition of PCE #2 has been substantially reduced (USFWS 2008). The current Delta has little of its historic intertidal marsh lands and many of its historic sloughs and channels have been cut off or altered. The pattern and quantity of inflow and outflow has been highly altered by upstream storage and diversions from the Delta. The 2-Gates project would reduce the amount of water drafted through Old River from Franks Tract. Water not drafted from the western Delta would be drawn from Middle River, Turner and Columbia Cuts and Old River upstream of the pumps. This would potentially benefit larval and juvenile delta smelt in the western Delta by reducing their movement into south Delta channels and subsequent loss via export facilities and could increase entrainment risk for juveniles in the eastern Delta.

In conclusion, the Project would have a net beneficial effect on designated critical habitat for delta smelt. Operations would enhance the condition of critical habitat by reducing entrainment risk in the south Delta (PCEs #2 and #3) and would not significantly degrade the condition of physical habitat (PCE #1).

5.4.2 Effects to Chinook Salmon and Steelhead

5.4.2.1 Potential Effects by Life History Stages

Winter-run and spring-run Chinook and CV steelhead occur in the Delta during their adult and juvenile migratory life history stages. Some extended rearing may also occur in the Delta during juvenile emigration. Potential effects for the different salmon runs and CV steelhead depend on the timing and the river systems they use. Runs that have peak migratory or rearing life history stages in the Delta during the construction and operation periods of the 2-Gate Project would have a higher potential to be affected by the project. Winter-run and spring-run Chinook and CV steelhead runs that access the Sacramento River and tributaries are less affected by the project compared to fall-run Chinook or CV steelhead runs using the San Joaquin or Mokelumne River systems.

The Biological Characteristics, Status of the Species and Critical Habitat (as applicable) for Winter-run and spring-run Chinook and CV steelhead are presented in Section 3. This analysis presents the effects common to all salmonids, followed by a description of unique attributes for individual runs based on the species, run timing or home river system. There is more information available for Chinook salmon than CV steelhead, but CV steelhead are expected to have similar behavioral responses once differences in run timing and distribution are accounted for.

EMIGRATION OF JUVENILE SALMON AND STEELHEAD THROUGH THE DELTA

Juvenile winter-run Chinook salmon generally occur in the Sacramento-San Joaquin Delta from December through April with a peak from February through April. Occurrence within the Delta may extend from October into June. The emigration period for spring-run Chinook salmon extends from November to early May. Juvenile spring-run Chinook salmon numbers are reported to peak in December and March and April in the lower Sacramento River and Sacramento-San Joaquin Delta. Historical Central Valley steelhead salvage data from the State Water Project and Central Valley Project provide salvage data indicate a high relative abundance of steelhead juveniles from February through May, moderate abundance in June and October – January, and minimal to no abundance from July – September. In summary most salmonid outmigration occurs from early winter through spring (October through May) and perhaps into June.

Project operations from December through June would likely reduce entrainment of juvenile salmon and steelhead moving though the Delta. Gate operations during March and June would also provide improved flow and salinity cues for salmon and steelhead migrating toward the ocean. Operations have the gates operated tidally (closed on flood and open on ebb tides) during March and June. During this time the gates will be closed on flood tides (up to 10 hours total daily) and opened on ebb and slack tides. The gates will be fully open from April 1 through May 31 each year during the San Joaquin River inflow/export ratio period under criteria established in the 2009 NMFS OCAP BO (see Action IV.2.1 at NMFS 2009). In its opinion, NMFS rationalizes that because studies indicate that higher spring San Joaquin River inflow relative to export pumping results in higher survival of outmigrating Chinook salmon, the same would hold true for outmigrating San Joaquin Basin and Calaveras River steelhead (NMFS 2009). In addition, they concluded that the San Joaquin River inflow versus export pumping relationship would also benefit Sacramento River salmon and steelhead which have been diverted into the interior Delta by increasing net Delta outflow. In any case, the 2 Gates project will maintain its gates in the fully open position during the San Joaquin River inflow/export ratio period of April 1 through May 31 each year to facilitate salmonid migration through the Delta by maintaining unobstructed migratory pathways through Old River and Connection Slough. Limiting negative flows in Old and Middle River to keep delta smelt north or west of the gate would also provide improved flow or salinity cues for salmon and steelhead migrating toward the ocean.

Juvenile steelhead emigrating from the Mokelumne and San Joaquin Rivers take migration paths that would be different from Sacramento River fish. Mokelumne River steelhead would migrate along the same route used by some Sacramento River steelhead or salmon that entered the central Delta via the DCC gates or Georgiana Slough. Operation of the 2-Gate Project includes an element to mitigate for entrainment of fish from those stations in the central Delta that are located around or upstream of the confluence of the Mokelumne River (Figure 5-2).

San Joaquin River steelhead could move through the Delta using several routes including moving into Old River downstream of Mossdale. Migration routes most likely take fish down the Grantline Canal before re-entering Old River near the intakes to the CVP and SWP. Project operations have been shown to control the distribution of juvenile delta smelt to keep them out of the south Delta. Therefore, operations would also reduce entrainment of juvenile salmon and steelhead into the pumping facilities by keeping them away from the south Delta. Operations to protect larval and juvenile smelt creates dispersive mixing within the central

Detla changing negtative flows in both Old and Middle River channels to negative in Middle River and positive (downstream) in Old River. This would tend to reduce entrainment risk for juvenile salmon and steelhead that are passing through the central Delta. The particle tracking model suggests that salmon or steelhead migrating down Old River and the Grantline Canal would be no worse off under this conditon, whereas particles released in the San Joaquin River and the central Delta show a marked reduction in entrainement with the 2-Gates project compared to OMR flows alone (Figure 5-2). Mokelumne River fish, however show slightly higher entrainment compared to OMR flows alone (Figure 5-2).

MIGRATION OF ADULT SALMON AND STEELHEAD THROUGH THE DELTA

Adult immigration of winter-run Sacramento River Chinook salmon through the Sacramento-San Joaquin Delta generally occurs from December through June with a peak in March, while the immigration of spring-run salmon occurs from March through September with a peak in May and June. Adult immigration of steelhead through the Sacramento-San Joaquin Delta generally occurs from September through May with the peak in December through February. Unlike other species of salmon, steelhead do not necessarily die after spawning and downstream moving post-spawn adult steelhead (kelts) move down through the Delta from January through May.

Construction of the project will occur outside of the winter-run migration period and at the extreme end of the spring-run migration period, and beginning of the steelhead run. Because of the location in the central Delta, winter and spring-run adults are highly unlikely to pass the gate sites during the construction period. It is also unlikely that Sacramento basin steelhead will pass the gates sites during the early period of their upstream migration, however adult steelhead may be making their way toward the Mokelumne or San Joaquin river systems and could pass the gate sites.

The Project would have limited effect on adult migrating salmonids since Sacramento River upstream migrating adults would not be expected to pass the project site on their way upstream. Downstream migration steelhead kelts could be exposed to Project operations, and could become disoriented in channels conveying water toward the pumping facilities as they seek a route to the ocean. However, Project operations should reduce strong negative flows from Old River and balance negative flows in Middle River, and therefore should reduce the risk of entrainment of kelts into the Middle and Old River channels.

5.4.2.2 Potential Effects on Salmon and Steelhead Designated Critical Habitat

The 2-Gates Project would affect designated critical habitat for CV steelhead in the Action Area (there is no designated critical habitat present for winter- or spring-run Chinook). CV steelhead designated critical habitat in the Delta region as a whole will not be adversely modified as a result of the 2-Gates Project. Part of the intrinsic values of the PCE's listed for CV Steelhead critical habitat in the Delta is unobstructed passage of emigrating fish through the region, with conditions free of obstacles or risks (i.e. entrainment, predation). This characteristic of the PCE's will be modified locally within Old River and Connection Slough by construction and operation of the 2-Gates structures since passage there would be intermittently obstructed during tidal operations. Hydrodynamic conditions created by Project operations may create conditions conducive to predators. Upstream passage for adults migrating through the Old River and Connection Slough channels to habitats on the San Joaquin River system may be partially obstructed during winter operations. Gates would be closed mostly during flood tide periods, but passage would occur during the ebb tide. Migrating adults would be able to pass the gates and proceed with their upstream migration. If gates are closed the fish may be delayed for up to 6 hours. Invesigations on adult migration delays have occurred in large river and are often associated with navigation through reservoirs. Effects can be related to egg viability, or redd quality but since the operations provide periodic opening for upstream passage, delayed migration for adult CV steelhead migrating through other interior Delta channels, will not be adversely affected by the 2-Gates Project.

The effect of gate operations on flows that can affect downstream passage by juveniles would be negligible. As with adults, this PCE (unobstructed passage) would only be modified locally, within Old River and Connection Slough at the sites of the gate structures. Since the gates will be closed intermittently, mostly during the flood tide, dominate flow upstream of the gates in Middle River would be toward the pumps, whereas flows in Old River would be variable - north of Railroad Cut it would be slack during gate closure or ebb during gate opening, whereas south of railroad cut, negative flow would dominate the channel. Juveniles passing the intakes for the CVP and SWP presently face negative flows in these channels. Operation of the 2-Gates would enhance downstream migration conditions in Old River between Woodward Canal and Railroad Cut by reducing negative flow. Negative flows would be markedly improved in Old River north of railroad cut compared to existing conditions, or conditions with only the OCAP BO restrictions. Juveniles that encounter closed gates during the ebb tide cycle could be delayed for up to about 6 hours and could be exposed to predation during that time. Downstream passage of juvenile CV steelhead migrating through other interior Delta channels will not be adversely affected by the 2 Gates Project.

The gate structures would affect the passage PCE by obstructing and increasing predation risk; however, this effect would localized and would not adversely affect overall critical habitat in the Delta. The gate structures would attract predatory fish and the increased velocity of flows passing through the narrow gates may disorient individual CV steelhead in the immediate vicinity and provide shear zones and turbulent eddies during certain tidal stages that would attract predators. Predation risk would be a concern for juvenile steelhead but not for adults migrating through the sites of the gate structures. Although there would be local adverse modification of the critical habitat PCE of unobstructed passage for CV steelhead juveniles, designated critical habitat in other interior Delta channels will not be adversely modified as a result of the 2 Gates Project. Improved flows for adult and juvenile CV steelhead migration will occur in other interior Delta channels as a result of 2 Gates Project installation and operations. Therefore, the overall conservation value of these structures would be to improve critical habitat characteristics throughout the area of designated critical habitat. –. The net effect would be neutral or beneficial. Outmigration success of juvenile CV steelhead approaching the gates from the north and east would be improved since they would encounter less negative flows and be more likely to follow ouflow patterns through the Middle River, reducing entrainment of steelhead from the Sacramento and Mokelumne river systems at the CVP and SWP facilities.

Freshwater rearing habitat, another PCE of the Delta, is currently in poor condition, with leveed and rip-rapped channels that have low habitat complexity and low abundance of food organisms, and offer little protection from predation. Project operations would temporarily alter tidal inundation patterns that could affect tidal shallow water habitat, but this change is minimized by the periodic, not permanent, gate closure. Physical condition of freshwater rearing habitat would be affected in a local area near the gates, but the Project would not adversely affect freshwater rearing habitat in the Delta as a whole, The net effect of the Project on the function of CV steelhead critical habitat within the Delta would be neutral or slightly beneficial by reducing the risk of entrainment for the majority of the CV Steelhead population, which emigrates from the Sacramento River basin.

5.4.3 Potential Effects on Southern DPS of North American Green Sturgeon

5.4.3.1 Potential Effects on Life History Stages

The widely recognized paucity of green sturgeon data makes it difficult to analyze project effects on individuals, the population and species (CALFED Science Review Panel 2009). Although considerable research progress has been made in recent years, information gaps remain. Behavior, movements, and habitat needs of early life stages are poorly understood. Data is lacking on the spatial and temporal distribution of juveniles in the Delta. In this situation, a qualitative analysis is the best available tool for evaluating effects on green sturgeon (CALFED Science Review Panel 2009).

Green sturgeon adults pass through the north Delta as they migrate from the ocean to the Sacramento basin in spring and outmigrate in early summer. Most movement by adults occurs in deeper channels. Juveniles occur in the Delta year-round, rearing one to three years before migrating to the ocean. Juveniles are more likely to use the shallow habitats for feeding and predator refuge (NMFS 2009). Juveniles are recovered at the fish facilities in all months, with higher levels of salvage during July and August (DFG 2002 cited in NMFS 2009) when the Project gates will not be operated.

The majority of juveniles salvaged or captured in DFG trawling studies were 200-500 mm (DFG 2002 cited in NMFS 2008a), indicating they were two to three years of age based on Klamath River age distribution studies (Nakamoto et al. 1995). Predation on juvenile green sturgeon near the gates is expected to be minimal, given their size and protective scutes (NMFS 2009).

Periodic closure of the gates could affect movements of juveniles and adults within the Delta, but the effect would be transitory. During December to early March, both gates would be closed about 1-2 hours daily. In late March and in June, the Old River gate would be closed twice daily on flood tides totaling up to 10 hours, and Connection Slough gate would be closed about 20 hours except on slack tides. Other Delta channels would remain available for movement. The project site is not along the adult migratory corridor and therefore the project would not impede passage to spawning habitat in the Sacramento basin. Alteration of the bottom substrate is not expected to affect directional movements of sturgeon. Telemetry studies of adults and subadults in San Pablo Bay documented green sturgeon on the bottom moving nondirectionally and presumably foraging, but swimming closer to the surface when moving directionally (Kelly et al. 2007). Flow velocities through the gates would be greater when the gates are initially opened because the channel will be narrower than under baseline conditions. These flows are not expected to prevent sturgeon movements because even juveniles are relatively large and strong swimmers.

Green sturgeon are tolerant of a wide range of environmental conditions experienced in the estuary (Kelly et al. 2007), so operational effects on water quality conditions are not expected to adversely affect this species.

5.4.3.2 Potential Effects on Southern DPS Green Sturgeon Proposed Critical Habitat

The Action Area encompasses part of the proposed critical habitat for green sturgeon, namely freshwater riverine systems. Specific PCE’s within the Delta are food resources, principally benthic invertebrates and fish, migratory corridor through the Delta and lower Sacramento River for adults and juveniles, and uncontaminated sediments. As discussed earlier (Construction Effects Section 5.2.3.4), installation of the gate structures will alter a small area of soft benthic habitat (approximately 1.6 acres, less than 0.15% of channel bottom in Old River alone), but the effect on food resources and sediment quality would be localized and would not impair the overall function of proposed critical habitat within the Delta. Project operations would not impair benthic habitat condition. Gate operations would not impede upstream migration of adults, because the two sites are not along the corridor from the ocean to spawning habitat in the upper Sacramento River. Periodic closure of the gates would have a transitory effect on movement corridors for juveniles residing within Old River and Connection Slough but would not affect passage through other interior Delta channels. The operations effects would not impair the condition of freshwater riverine habitat currently available in the Delta.

5.5 MONITORING THE EFFECTS OF PROJECT RESPONSE MONITORING ON AQUATIC SPECIES

Increased sampling periods and intensity of delta smelt larvae and juveniles, additional tagging and observational studies requiring handling of fish and disturbance of habitats, may affect individual organisms in various ways. In general, knowledge gained from more precise real-time reliant decision making support data (water quality, hydrodynamics, and species presence data) will have a greater benefit to populations affected by entrainment or migration than the incidental take incurred during monitoring. In general, supplemental efforts toward existing studies that includes fish handling and tagging, will be considered under the Incidental Take Permit those programs are operating under. The 2 Gates Project estimated number of additional juvenile salmonids that may be handled on any year during the course of the studies is between 25 and 250 indivuduals. These are primarily for radio-tagging in which the mortality from tagging and handling is so low as to be discountable.

5.5.1 Water Quality and Flow Monitoring

Water quality and flow monitoring are expected to use existing station and networks using passive devices (grab sampling, deployed meters, etc.) and have no long-term effect on aquatic species. Maintenance of in-stream devices could create temporary disturbance from foot traffic or boat traffic where fish may leave the area.

5.5.2 Fish Monitoring

Seven fundamental fish monitoring programs operate within the Delta and include: Fall midwater trawl, Summer townet survey, spring Kodiak trawl, 20mm post-larval and juvenile delta smelt survey, the Mossdale Kodiak trawl survey, the Longfin smelt survey, and fish salvage monitoring. These programs have been evaluated for their potential effects and have been permitted for sampling, handling and take under various Delta evaluation programs.

5.5.3 Additional Monitoring or Enhancement of Existing Programs

5.5.3.1 Water Quality

The project's water quality monitoring includes initial deployment and weekly maintenance by technicians. The action includes a boat trip, and retrieval and redeployment of instruments. Technicians will use established boat access areas or hand carry smaller boats down the bank. These actions may temporarily disperse fish associating with the area but overall should have little to no effect on aquatic species.

5.5.3.2 Fish Monitoring

Spring Kodiak Trawl (SKT) The SKT time period will be expanded into December and sampling frequency at sites near the project area will increase to once/week. The intent of the extension is to achieve an earlier indication of entrainment risk when the gates are in operation. This will be at earlier period of the delta smelt spawning migrations, therefore lower abundance is expected form sample captures. The benefit of an earlier sample period to inform gate operation should compensate in overall greater survival of smelt than not having an extended sample period.

20mm Juvenile Smelt Survey The 20mm survey will increase in frequency from bi-weekly to weekly. Average mortalities will presumably be doubled at eight sample sites within the Project's area of influence.

Stationary Trawl to Validtate Adult Delta Smelt Migration Behavior To support the turbidity/migration hypotheses underlying the 2-Gates operations, a special trawl study will be conducted at 2 key points (Sacramento River near Decker Island and San Joaquin River at Jersey Point) triggered by the first major rain event of winter. To detect adult smelt movement into the delta during this period up to 6 trawls will occur at each site (about every two hours, through a 12 hour tidal cycle.) Most smelt captured in trawls die. The catch however is highly variable from trawl to trawl.

A trawl-cam is in development that will be ready for testing this spring. The trawl-cam replaces the closed cod end of the net with a camera system capable of identifying, measuring and counting the catch. The catch is then passed out the end of net unharmed. Software associated with the cameras are able to identify species and sizes in turbid water. Once testing of the trawl is complete, the divice would need to calibrated to trawls used for historic sampling.

Juvenile Salmon/Steelhead Emigration Studies Central Valley salmon and steelhead tagging-based studies are shifting towards acoustic tag technologies. Generally, this involves the use of handling less fish for management information compared to traditional coded wire tag or other mark-recapture techniques. Active and planned studies such as VAMP-related research and East Bay Municipal Utility's delta migratory juvenile salmonid survival study schedule for 2010 utilize hydroacoustic technologies. 2-Gates salmonid evaluations propose to utilize this information and receiver network where feasible and provide additional location information for existing studies by establishing receiving stations in the Project area. The 2-Gate explicit evaluations will require tagging of additional salmonids for site specific information and may include up to 500 individuals. Hydroacoustic tags have demonstrated very low mortality rates on salmonids from handling and tagging when recommended tag weight to fish weight ratios are adhered to, however; Adams et al (1998) and Adams et al (1998b) describe other behavioral and physiological effects that could affect individuals. Since the 2-Gate evaluations are supplemental studies to the migration/behavioral studies in existence, little to no impact on total fish populations is expected from the use of these additional fish.

Monitoring for Predators Video and sonic cameras and fish finders will be used to periodically inspect gate areas for predators. Other than the potential for fish to avoid movement of the boat and be temporarily displaced upon positing the boat, the practice will be passive and have no effect on populations of fish. Authorized electrofishing may cause mortalities of predator or non-native fishes and may also cause mortality of delta smelt and salmonids. Prudent electrofishing protocol, such as no electrofishing, gill netting or angling if salmonids or native fishes are harmed during collection, will minimize negative effects on native fishes.

5.6 EFFECTS ON TERRESTRIAL SPECIES

Pursuant to section 7(a)(2) of the ESA (16 U.S.C.§1536), Federal agencies are directed to ensure that their activities are not likely to jeopardize the continued existence of any listed species or result in the destruction or adverse modification of critical habitat. The action may adversely affect giant garter snake if they are found within the Action Area. Based on the results of the dry- and wet-season surveys, no vernal pool fairy shrimp, vernal pool tadpole shrimp, or Conservancy fairy shrimp were detected, and the habitat was determined to be unsuitable for these species. There are no interrelated or interdependent activities related to the action that would affect terrestrial species.

5.6.1.1 Giant Garter Snake (GGS)

Habitat potentially suitable for Giant Garter Snake (GGS) is present at both gate locations. The Project site is within habitat designated for the recovery of the species (USFWS 1999), and GGS is assumed to be present. Construction of the Project has the potential to take individual snakes if they are present in the area subject to disturbance. GGS are active during the summer (season defined May 1 to September 30) and hibernate in upland burrows and refugia during the winter (season defined October 1 to April 30). Construction activities and site disturbance between May 1 and September 30 could result in the take of snakes during their active period, if present within the area subject to disturbance. Although unlikely, foraging, resting, or migrating GGS could be directly killed by vehicular traffic on the levee roads accessing the Project site, or by construction equipment within the Project site. Land-based disturbance would occur during initial construction in September (during the active season), and gate removal in 2014 would be conducted during the active period of GGS.

All site disturbances that have the potential to result in a take of GGS will be conducted during the active period for GGS between May 1 and September 30. Installation of the barge and gates during November would involve access along the roads, but would not impact GGS because there would be no earthmoving work that could disturb, expose or entomb GGS hibernating in upland refugia, and GGS would not be present above ground on roadways during this period.

Project construction may result in a temporary loss of habitat for GGS as upland refugia and burrows suitable for hibernation may be crushed by earthmoving equipment, and debris piles that function as upland refugia are removed from within the laydown areas to accommodate construction activities. The removal of emergent and riparian vegetation along the banks of Old River and Connection Slough, as well as the removal of upland vegetation within the construction zone could expose GGS to predation. The loss of upland refugia and vegetative cover within the Project construction zone would be short-term impacts as burrowing mammals would likely recolonize areas disturbed during construction, and vegetative cover would be quickly reestablished following disturbance. Furthermore, the 2-Gates Project is short-term by design, as it is intended to serve as a pilot project to test the effectiveness of these seasonally operated gates on the aquatic species of concern. The effects of the Project on GGS would occur principally during construction activities and the removal of the gates in 2014.

Gate operations are not expected to impact giant garter snakes or significantly impede their movement. The gates would be opened and closed over a period of approximately 10 minutes. The snakes are highly mobile and would be able to move away from the gates during operation, and around the sheet piles on the levees when the gates are closed.

5.6.1.2 Vernal Pool Fairy Shrimp, Vernal Pool Tadpole Shrimp, Conservancy Fairy Shrimp

As discussed in Sections 3.2.2 to 3.2.4, no listed large branchiopods were detected during wet- and dry-season surveys. Since the wetland never ponded water during any of the wet season site visits, the wetland basin was determined to be unsuitable for federally-listed large branchiopods. The wet- and dry-season reports are enclosed in Appendix J. Therefore the Project will have no effect on these species.