RECLAMATION

Managing Water in the West

Environmental Assessment

Delta Smelt Fall Habitat Action in 2019

U.S. Department of the Interior
Bureau of Reclamation
Mid Pacific Region

AUGUST 2019

Mission Statements

The Department of the Interior protects and manages the Nation's natural resources and cultural heritage; provides scientific and other information about those resources; and honors its trust responsibilities or special commitments to American Indians, Alaska Natives, and affiliated island communities.

The mission of the Bureau of Reclamation is to manage, develop, and protect water and related resources in an environmentally and economically sound manner in the interest of the American public.

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List of Acronyms and Abbreviations

2008 BO	2008 Fish and Wildlife Service Biological Opinion on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project
2016 ROD	Record of Decision from the Long-Term Operations Environmental Impact Statement
2017 Action	Delta Smelt Outflow Action in 2017
Action 4	RPA Component 3 - Action 4: Estuarine Habitat During Fall
AMP	Adaptive Management of Fall Outflow for Delta Smelt and Water Supply Reliability
BO	Biological opinion
CAMT	Collaborative Adaptive Management Team
CDEC	California Data Exchange Center
CDFW	California Department of Fish and Wildlife
CFR	Code of Federal Regulations
cfs	cubic feet per second
COA	Coordinated Operation Agreement
CSAMP	Collaborative Science and Adaptive Management Program
CVP	Central Valley Project
CVPIA	Central Valley Project Improvement Act
D-1641	SWRCB Decision 1641
Delta	Sacramento-San Joaquin Delta Estuary
DOP	Directed Outflow Project
DPS	Distinct Population Segment
DSRS	Delta Smelt Resiliency Strategy
DSM2	Delta Simulation Model II
DWR	California Department of Water Resources
EA	Environmental Assessment
EC	electrical conductivity
EDSM	Enhanced Delta Smelt Monitoring
EFH	Essential Fish Habitat
EIS	Environmental Impact Statement
EMP	Environmental Monitoring Program
ESA	Endangered Species Act
ESU	Evolutionarily Significant Unit
FLaSH	Fall Low Salinity Habitat Studies and Adaptive Management
FLOAT-MAST	Flow-Alteration-Management, Analysis, and Synthesis Team
FMWT	Fall Mid-water Trawl
FONNSI	Finding of No New Significant Impact
FR	Federal Register
IEP	Interagency Ecological Program
JPOD	Joint Point of Diversion
km	kilometer
LTO	Long-Term Operations
LTO EIS	2015 Long-Term Operations Environmental Impact Statement

LSZ	Low-salinity zone
MAST	Management, Analysis, and Synthesis Team
mg/l	milligrams per liter
umhos/cm	micromhos per centimeter
mmhos/cm	millimhos per centimeter
NEPA	National Environmental Policy Act
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Units
PCE	Primary Constituent Elements
ppt	parts per thousand salinity
Proposed Action	Proposed Delta Smelt Fall Habitat Action in 2019
psu	practical salinity units
Reclamation	Bureau of Reclamation
Reclamation 2017	Delta Smelt Fall Outflow in 2017 Environmental Assessment
ROC on LTO	Reinitiation of Consultation
RPA	Reasonable and Prudent Alternative
Service	U.S. Fish and Wildlife Service
SMSCG	Suisun Marsh Salinity Control Gates
STN	Summer Tow Net
SWP	State Water Project
SWRCB	California State Water Resources Control Board
TAF	Thousand acre-feet
TDS	Total Dissolved Solids
USC	U.S. Code
WY	Water Year
X2	two parts per thousand salinity isohaline

Section 1 Introduction

In conformance with the National Environmental Policy Act, 42 U.S.C. § 4431 et seq. (NEPA), as amended, the Bureau of Reclamation (Reclamation) has prepared this Environmental Assessment (EA) to evaluate and disclose potential environmental impacts associated with implementation of the Delta Smelt Fall Habitat Action in 2019 (Proposed Action).

This EA describes the existing environmental resources in the project area and evaluates the impacts of the No Action and Proposed Action alternatives. This EA was prepared in accordance with NEPA, Council on Environmental Quality regulations (40 Code of Federal Regulations (CFR) 1500-1508), and Department of the Interior Regulations (43 CFR Part 46).

Compliance with NEPA is a Federal responsibility and involves the participation of Federal, State, tribal, and local agencies, as well as concerned and affected members of the public in the planning process. NEPA requires that Federal agencies analyze and disclose the potential environmental impacts and possible mitigation for Federal actions and a reasonable range of alternatives to the proposed action. NEPA is required when a discretionary Federal action is proposed. The regulations (40 CFR 1508.18(a)) define a Federal action as including new and continuing activities, actions partly or entirely financed by Federal agencies (where some control and responsibility over the action remain with the Federal agency [43 CFR 46.100]), actions conducted by Federal agencies, actions approved by Federal agencies, new or revised agency rules or regulations, and proposals for legislation. NEPA applies when a Federal agency has discretion to choose among one or more alternative means of accomplishing a goal.

This EA is tiered (40 CFR 1502.20 and 1508.28) from the LTO EIS and 2016 ROD. It also incorporates by reference the Delta Smelt Fall Outflow 2017 EA and Finding of No New Significant Impact (FONNSI). Analyses included in this EA are based on the information and analyses included in the LTO EIS, and the Delta Smelt Fall Outflow 2017 EA. The LTO EIS and 2016 ROD are available online at:

https://www.usbr.gov/mp/nepa/nepa_projdetails.cfm?Project_ID=21883

The Delta Smelt Fall Outflow 2017 EA and FONNSI are available online at:

https://www.usbr.gov/mp/nepa/nepa_project_details.php?Project_ID=30266

1.1 Background

The low-salinity zone (LSZ) is a commonly used metric in the Sacramento-San Joaquin Bay-Delta (Delta) of relevance to Delta Smelt (*Hypomesus transpacificus*). The LSZ occurs at the inland edge of the estuarine habitat where freshwater meets saltwater (Kimmerer 2004). The LSZ moves upstream and downstream depending on flows and tides. X2 is the location in the LSZ in the Delta where the tidally averaged salinity is 2 parts per thousand salinity (ppt) isohaline. X2 is described as distance in kilometers (km) from the Golden Gate Bridge (Jassby et al 1995) (Figure 1). For example, an X2 at 81 km is when the average daily salinity at the bottom of the

water is 2 ppt and is located near Collinsville, CA. The location of X2 is commonly reported in practical salinity units (psu), in accordance with a change in units in 1978. However, psu are approximately equivalent to ppt. The location of X2 is also used as an indicator of Delta outflow and habitat suitability for organisms in the San Francisco Estuary.

In 2008, the US Fish and Wildlife Service (Service) provided Reclamation a Biological Opinion (BO) on the Coordinated Long-Term Operation of the Central Valley Project (CVP) and State Water Project (SWP) under Section 7 of the Endangered Species Act (ESA) (2008 BO). The 2008 BO concluded that, as proposed, the CVP and SWP operations were likely to jeopardize the continued existence of Delta Smelt and adversely modify its critical habitat. The 2008 BO set forth a Reasonable and Prudent Alternative (RPA) with actions that allow for continued operation of the CVP and SWP without jeopardizing and adversely modifying Delta Smelt or its critical habitat. The RPA actions include revised water operations and habitat restoration and enhancement.

The 2008 BO includes RPA Component 3 - Action 4: *Estuarine Habitat During Fall* (Action 4). An objective of Action 4 is to improve Delta Smelt fall habitat in an Above Normal or Wet Year by increasing Delta outflow. Action 4 calls for providing sufficient Delta outflow to maintain average X2 for September and October no further upstream than 74 km in the fall following Wet Years; and 81 km in the fall following Above Normal Years. Water Years are based upon the Sacramento Basin 40-30-30 index in the State Water Resources Control Board (SWRCB) Decision 1641 (D-1641). In November of these years, there is no specific X2 requirement; however, there is a requirement that all inflow into SWP and CVP upstream reservoirs be conveyed downstream to augment Delta outflow to maintain X2 at the locations in September and October. If storage increases during November under Action 4, the increased storage volume is to be released in December in addition to the requirements under SWRCB D-1641 net Delta Outflow Index.

Action 4 describes that the Fall X2 action be adaptively managed, to ensure the implementation of the action addresses the uncertainties of its effectiveness and water-efficiency. Action 4 states that as new information is developed and as circumstances warrant, changes to Action 4 itself may be necessary. In 2011, Reclamation provided the Service with an updated Adaptive Management Plan that provided a framework to implement Fall X2.

The 2008 BO uses X2 as a surrogate indicator of habitat suitability and availability for Delta Smelt in all years. Action 4 focuses on Wet and Above Normal years because these years are most affected by operations in the fall. In 2014, the U.S. Court of Appeals for the Ninth Circuit upheld the 2008 BO, including Fall X2 action and its adaptive management, under the ESA. The Proposed Action described later in the document considers X2 as a surrogate indicator of habitat suitability and availability.

Coordinated Operation of the CVP and SWP

The CVP and SWP are operated in a coordinated manner in accordance with Public Law 99-546 (October 27, 1986) directing the Secretary of the Interior to execute the Coordinated Operation Agreement (COA). The COA is an agreement between the United States and the State of

California for the coordinated operation of the CVP and the SWP. COA defines the project facilities and their water supplies, coordinates operational procedures, identifies formulas for sharing joint responsibilities for meeting Delta standards (as the standards existed in SWRCB Decision 1485) and other legal uses of water, identifies how unstored flow would be shared, establishes a framework for exchange of water and services between the CVP and SWP, and provides for periodic review of the agreement.

In 2018, Reclamation and the California Department of Water Resources (DWR) amended four key elements of the COA to address changes since the COA was signed: (1) in-basin uses; (2) export restrictions; (3) CVP use of Banks Pumping Plant up to 195,000 acre-feet per year; and (4) periodic review. The COA sharing percentages for meeting Sacramento Valley in-basin uses now vary from 80% responsibility of the United States and 20% responsibility of the state of California in wet year types to 60% responsibility of the United States and 40% responsibility of the state of California in critical year types.

The CVP and SWP are permitted by the SWRCB to store water during wet periods, divert water that is surplus to the Delta as a common water supply, and re-divert CVP and SWP water that has been stored in upstream reservoirs. The CVP and SWP have built water storage and water delivery facilities in the Central Valley to deliver water supplies to affected water rights holders as well as CVP and SWP water contractors. The CVP's and SWP's water rights are conditioned by the SWRCB to protect the beneficial uses of water within each respective project and jointly for the protection of beneficial uses in the Delta.

As conditions of the water right permits and licenses, the SWRCB requires the CVP and SWP to meet specific water quality and operational criteria within the Delta. Reclamation and DWR coordinate operation of the CVP and SWP, respectively, to meet these and other operating requirements pursuant to COA.

Adoption of the Central Valley Project Improvement Act (CVPIA) in 1992 changed purposes and operations of the CVP. Water quality and flow standards have been revised by the SWRCB since 1986, such as SWRCB D-1641, adopted in 2000. DWR and Reclamation have operational arrangements to accommodate new facilities, water quality and flow objectives, the CVPIA, SWRCB criteria, and ESA.

Adaptive Management of Fall Outflow for Delta Smelt and Water Supply Reliability

In August 2011, Reclamation transmitted to the Service the Adaptive Management of Fall Outflow for Delta Smelt and Water Supply Reliability (AMP), which the Service found consistent with the RPA. Although the AMP did not establish specific management actions beyond 2011, it provided a framework that could be used for adaptively managing the action in future years. The AMP includes a review of Action 4 and evaluates habitat, X2 as a surrogate, evidence for the link between habitat and abundance, hydrology, and specifics of action. The key questions identified in the AMP that remain unanswered include ecological mechanisms that link outflow to abundance, other drivers of abundance, and if there are more water-efficient ways to provide the necessary benefits.

The first three adaptive management elements were to be completed before the first fall after Reclamation adopted the BO. These three adaptive management elements include: 1.) Creation of a delta smelt habitat group; 2.) Conceptual model review and preparation of study design, and 3.) Development of performance measures.[i]

The first element is the creation of a Delta Smelt habitat study group, which is a group of scientists under the guidance of the Service tasked with reviewing and improving the fall habitat conceptual model, designing performance measures, and preparing a study plan to improve scientific understanding of Delta Smelt habitat. This element is satisfied through the Collaborative Science and Adaptive Management Program (CSAMP), and its Collaborative Adaptive Management Team (CAMT).

CSAMP was established in 2013 as an outgrowth of litigation over the salmonid and Delta Smelt biological opinions, CSAMP is an applied science program designed to inform decisions regarding operations of the CVP/SWP and species protection in the Delta. The intent of the program is to facilitate collaboration to address uncertainties and promote understanding. CSAMP consists of a policy group of stakeholders and resources agencies, including Reclamation and the Service. Next in the tiered-structure of the collaborative initiative is the Collaborative Adaptive Management Team (CAMT), which is composed of senior scientists and high-level managers from State and Federal agencies, public water agencies, and environmental non-governmental organizations. CAMT helps direct the Delta Smelt Scoping Team by providing management relevant questions that may require further studies and analyses to address.

The second and third elements are conceptual model review, and development of study design and performance measures. On August 9, 2011, Reclamation completed its Fall Outflow Adaptive Management Plan. The adaptive management plan was revised and re-issued on June 28, 2012. The 2012 revised adaptive management plan considered the 2010 National Research Council peer review of the BO's RPAs and the 2010 Pelagic Organism Decline Synthesis Report. The 2012 Fall Outflow Adaptive Management Plan provides a study plan that reviews existing hypotheses and conceptual models, describes goals and objectives (performance measures) and methods for review and feed-back.

Reclamation completed a fall habitat operations plan in 2011, and the Service approved that plan. The 2011 implementation of the Fall Habitat RPA was monitored, and studies and evaluations were completed. The results of the 2011 adaptive management studies were evaluated in the FLaSH report. The 2011 action was further evaluated in the Interagency Ecological Program (IEP) MAST report.

After 2011, there was an extended multi-year drought. Since the Fall Habitat RPA is only triggered in wet and above-normal water years, the Fall Habitat RPA was not triggered again until 2017. The 2017 Fall Habitat Adaptive Management Plan evaluated the conceptual models described in the 2012 Fall Habitat Adaptive Management Plan and made predictions as to the expected outcomes. The 2017 Fall Habitat Action was reviewed by CAMT's Delta Smelt Scoping Team and the final Adaptive Management Plan responded to their comments. The 2017 Fall Habitat Action included monitoring. The results of the 2017 adaptive management studies

are analyzed and reported in the FLOAT-MAST and in Reclamation's Preliminary Draft Outflow Investigations Report.

The Service has been continually involved in the review and analysis of the results of implementation of the Fall Habitat RPA, being an author and reviewer of the FLaSH, FLOAT-MAST, MAST and Outflow Investigations reports. The BO provides the Service with the authority and responsibility to review and adjust the Fall Habitat RPA based on best available science as part of the adaptive management program. In 2017, the Service adjusted the RPA based on scientific investigations that had occurred since the BO, including the FLaSH and MAST analysis of the 2011 Action. The BO states that, "This action may be modified by the Service consistent with the intention of this action based on information provided by the adaptive management program in consideration of the needs of other listed species. Other CVP/SWP obligations may also be considered."

Delta Smelt Outflow Action in 2017

In its 2017 letter to the Service and the draft EA, Reclamation initially proposed to operate to achieve a monthly average X2 location of 74 km in September and no greater (more eastward) than 81 km in October. The Service sent a memo on September 27, 2017, amending the 2008 BO to allow Reclamation to operate to achieve an average X2 location no greater than 80 km in October of 2017. The Delta Smelt Outflow Action in 2017 (2017 Action) was consistent with Action 4 of the RPA in that it sought to work within the Adaptive Management parameters of the action described in the 2008 BO and selected alternative in the 2015 Long-Term Operations Environmental Impact Statement's (LTO EIS) 2016 Record of Decision (2016 ROD).

The 2017 Action represented an X2 location downstream of the Action 4 prescription for an Above Normal Water Year. Upstream CVP reservoir releases and storage did not change during the 2017 Action. The only operational changes to CVP that occurred were differences in south Delta exports in October; whereas, the export levels for September did not change. According to California Data Exchange Center (CDEC) data, in 2017, the average X2 locations were 74 km in September and 77 km in October.

In 2017, DWR was unable to operate to 80 km, instead operating to 74 km, because the California Department of Fish and Wildlife did not provide their approval.

Operations of the Suisun Marsh Salinity Control Gates in 2018

Summer operation of the Suisun Marsh Salinity Control Gates (SMSCG) is one of the actions outlined in the California Natural Resource Agency's Delta Smelt Resiliency Strategy (DSRS) (2016) to benefit juvenile and sub-adult life stages of Delta Smelt. It was anticipated that summer operation of the SMSCG would have the effect of reducing salinity in and around the Suisun Marsh while increasing prey availability. In 2018, Reclamation and DWR implemented a pilot study to test the potential effects of increased operations. Reclamation requested concurrence that the one-month 2018 pilot study will not result in adverse effects to delta smelt and its critical habitat not previously analyzed in the 2008 BO based on their expectation the proposed action will be wholly beneficial to the species and critical habitat. The Service determined that the

temporary modification to the project description underlying the 2008 BO due to the SMSCG pilot study and its associated Incidental Take Statement is consistent with and is covered by the Incidental Take Statement as issued in 2008 and the authorization it provides. Reclamation also analyzed the effect of the 2018 pilot study on listed Salmonids and determined it would not result in effects beyond those analyzed in the 2009 BO The 2018 pilot study showed that Delta Smelt entered the habitat surrounding the SMSCG during increased operations, salinity conditions similar to (or Better Than) high flow summers and increased turbidity.

Delta Smelt Studies

New scientific information has been developed since the 2008 BO. Results from these studies, and other new scientific information, are included in the effects analysis. Reclamation is committed to studies that will help provide scientific information for use in the recovery of Delta Smelt. These efforts include the following:

- **Directed Outflow Project (DOP):** The DOP is a group of related studies designed to evaluate the effect of outflow alteration on Delta Smelt habitat and improve our understanding of the mechanisms and drivers affecting Delta Smelt vital rates and behavior. This project builds on knowledge gained and lessons learned from previous studies, such as the Fall Low Salinity Habitat (FLaSH) (Brown et al. 2014) and Delta Smelt Management, Analysis, and Synthesis Team (MAST) reports (Baxter et al. 2015). Studies include collection of additional habitat data taken concurrently with fish data collected by Service's Enhanced Delta Smelt Monitoring (EDSM) program. Results should assist in evaluating the benefit and feasibility of future flow augmentation actions for managers and decision makers. Results from this and other related studies will inform evaluations on which particular outflow-related action or group of actions provides the most benefit for Delta Smelt.

- **Interagency Ecological Program (IEP):** In 2011, the IEP MAST released the FLaSH report to suggest studies to explore the importance of fall low-salinity habitat for Delta Smelt. The IEP MAST also developed the Delta Smelt MAST Report in 2015, which included an updated Delta Smelt conceptual model.

- **EDSM:** The EDSM is a year-round weekly sampling program administered by the Service and voluntarily funded by Reclamation. Pilot sampling began in November 2016, with full-scale sampling starting in January 2017. The EDSM aims to provide weekly estimates of abundance and distribution for most life stages of Delta Smelt across its range. These estimates are intended to provide finer temporal resolution to historical Delta Smelt monitoring data, provide early warning of potential adult Delta Smelt entrainment events during the spawning period, and to support Delta Smelt life cycle and entrainment modeling efforts.

- **Mesocosm (Cage) Studies:** DWR is leading a study placing cultured Delta Smelt into large mesocosms (floating perforated metal cages) located in the Delta. The University of California-Davis, through funding from Reclamation and associated DOP projects, will perform analyses of the health and growth, of Delta Smelt used in the DWR-led cage

study. The projects will help better link augmentation of outflow to observed responses of Delta Smelt.

- **Environmental Monitoring Program (EMP):** Through the IEP, Reclamation and DWR maintain an extensive network of monitoring for parameters relevant to Delta Smelt, e.g. the EMP. This includes salinity, water temperature, turbidity, food, and fish community surveys throughout all regions of interest during the summer and fall. Additional physical environment monitoring will be completed consistent with Reclamation's Deep Water Ship Channel nutrient manipulation study.

- **Drivers of Delta Smelt Health:** The Drivers of Delta Smelt Health study uses Delta Smelt collected from existing monitoring programs to evaluate fish health and condition. This data will be used to establish a conceptual framework that investigates relationships among stressor effects, ecosystem variables, and the health indices of Delta Smelt to improve our understanding of the species and its decline. This will be accomplished by determining how fish health indices (e.g., biomarkers of exposure and effects, nutritional status) relate to Delta Smelt health and reproductive condition, by conducting a regional comparison of juvenile Delta Smelt condition using archived Delta Smelt, quantifying the foraging and metabolic consequences of semi-anadromy for Delta Smelt, and determining the sensitivity of the biomarkers through the use of starvation experiments with captive-bred Delta Smelt. This study also contributes in evaluating predictions associated with outflow and Delta Smelt and is part of several projects associated with the ongoing DOP.

- **Salinity and Growth History of Delta Smelt:** The Salinity and Growth History of Delta Smelt study will use otoliths to determine growth rates and salinity history (habitat use) of Delta Smelt captured by existing monitoring programs. Growth rates will be determined by enumerating otolith increments and quantifying growth increment widths. Salinity history will be determined by using strontium isotope ratios by determining the mixture of freshwater strontium isotope ratios, which are associated with the volume of Sacramento and San Joaquin River water, with the globally stable marine strontium isotope ratio. This technique will be used to reconstruct the salinity history using the strontium isotope ratios and will be reported as the amount of time spent in different salinity habitats across varying environmental conditions. This study also contributes to evaluating predictions associated with outflow and Delta Smelt and is part of several projects associated with the ongoing DOP.

- **Delta Outflow Augmentation Modeling:** The Delta Outflow Augmentation Modeling study will use the UnTRIM San Francisco Bay-Delta model (a three-dimensional hydrodynamic model of San Francisco Bay and the Sacramento-San Joaquin Delta) to predict salinity, tidal flows, and water levels throughout the San Francisco Bay and Sacramento-San Joaquin Delta under a wide range of conditions. UnTRIM will be used to simulate various potential outflow actions, help select the best option, and to evaluate the outcomes of selected actions as compared to other potential outflow actions.

- **Roaring River Distribution System Restoration:** Experimentally produces food through wetland management in the Suisun Bay and Marsh.

- **Sacramento Deepwater Ship Channel nutrient manipulation**: Involves experimentally seeding nutrients in the Deepwater Ship Channel to enhance productivity in Cache Slough.

1.2 Purpose and Need for the Proposal

The purpose of the Proposed Action is to provide fall habitat for Delta Smelt in 2019 through adaptively managing the implementation of Fall X2 and meeting the objective of Action 4 of the 2008 BO RPA. The need for the action is to strike a balance between the biological goals and effectiveness of Action 4 and water supply based on new scientific information that suggests there are alternatives to meet the biological goals of Action 4 of the 2008 BO RPA.

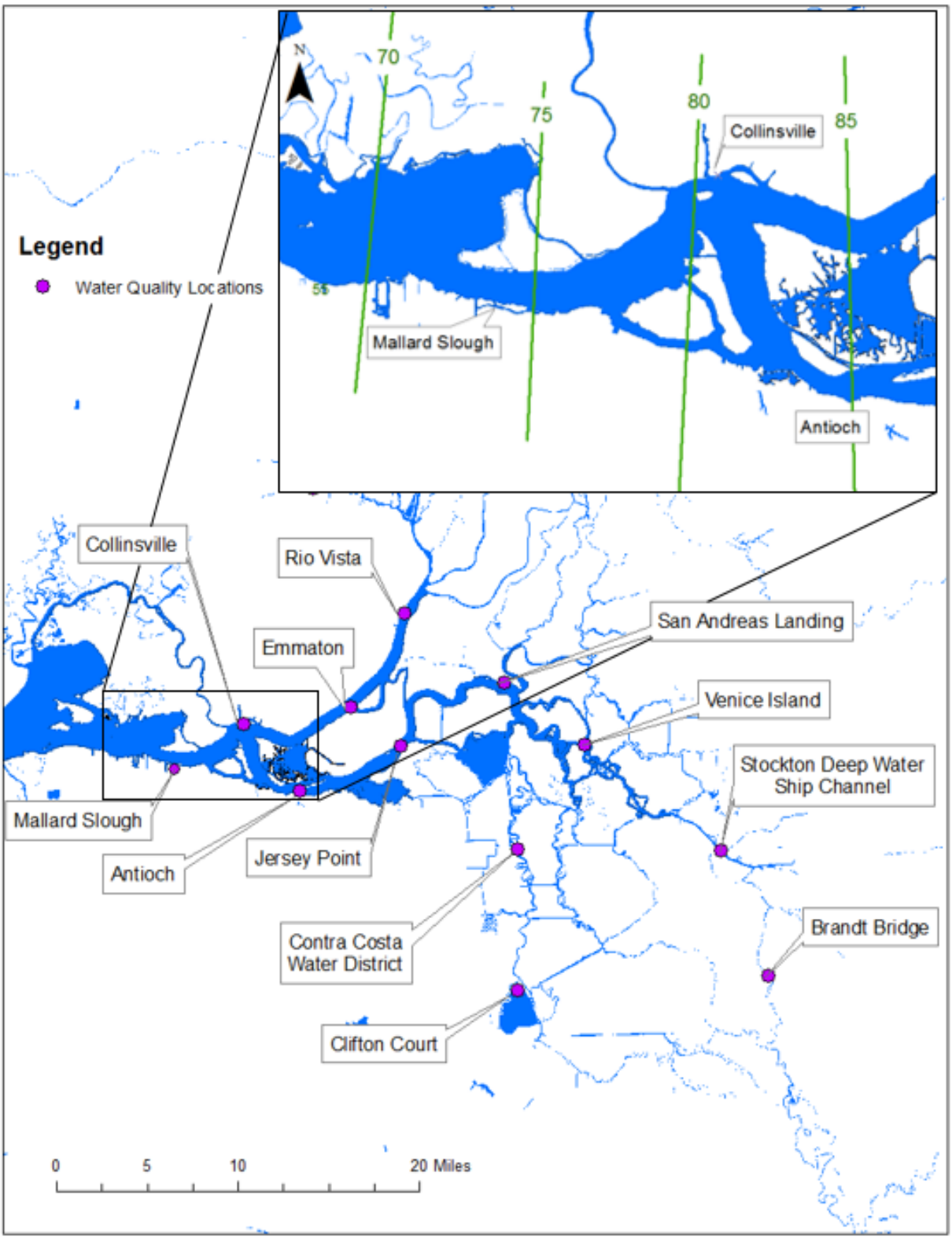

Figure 1. Delta water quality locations of interest and distances from Golden Gate in km

Section 2 Alternatives Including the Proposed Action

This EA considers two possible alternatives: No Action Alternative and the Proposed Action. The No Action Alternative reflects future conditions without the Proposed Action and serves as a basis of comparison for determining potential impacts to the human environment that would result from implementation of the Proposed Action.

Identification of the reasonable range of alternatives for this EA was based upon consideration of the purpose and need for the proposal. Reclamation considered alternatives that struck a balance between the biological goals and effectiveness of Action 4 and water supply. Additional alternatives were considered that did not meet the balance described in the purpose and need as describes in Section 1.2. Alternatives were eliminated that would be outside of the bounds (X2 km) between the Proposed Action (80 km) and the No Action Alternative (74 km) as they would not meet the need for the proposal. For example, an X2 value of greater than 80 km would not provide for the biological goals for the Delta Smelt. For reasons described in this EA and in Appendix A, 80 km would meet the balance between the biological goals and the water supply flexibility.

2.1 No Action Alternative

The No Action Alternative is defined as no change in management direction. It continues with current implementation of the 2008 BO as described in the 2016 ROD. Under the No Action Alternative, in 2019 Reclamation and DWR would not implement the proposed fall action for Delta Smelt habitat. Reclamation would maintain a monthly average X2 of 74 km in September and October in accordance with the 2008 BO and 2016 ROD existing prescriptions following a Wet Year.

2.2 Proposed Action Alternative

Habitat conditions and quantity in summer 2019 should be favorable for Delta Smelt, with low salinity habitat extending west of the Sacramento-San Joaquin River confluence and throughout Suisun Marsh.[ii] The Proposed Fall Habitat Action (Proposed Action) for Delta Smelt habitat in Water Year (WY) 2019 will achieve the Action 4 objective. New science and monitoring information on the Delta Smelt informed the Proposed Action. Action 4 of the 2008 BO requires adaptive management to ensure that the implementation addresses the "uncertainties about the efficiency of the action" (page 369 of 2008 BO). Action 4 also states that as new information is developed and as circumstances warrant, changes by the Service to the Fall X2 action itself may be necessary. The Proposed Action is a plan to adaptively manage and modify its operation of the CVP/SWP under RPA Action 4.

It is expected that summer habitat conditions should be accommodating for Delta Smelt across the Suisun Marsh and western Delta. This Proposed Action will maintain favorable habitat conditions in these regions during the fall. Consistent with new scientific information of the Delta Smelt designated critical habitat, the following actions are proposed for 2019:

- Fall Habitat Action, and
- SMSCG Action.

Fall Habitat:
The FLaSH conceptual model suggests that Delta Smelt habitat should include salinity conditions ranging from fresh to low salinity (0-6 ppt), minimum turbidity of approximately 12 Nephelometric Turbidity Units (NTU) for adults, temperatures below 23°C, food availability, and bathymetric complexity (FLaSH Synthesis, pp. 15-23; Komoroske et al. 2015). The goal of the Proposed Action is to provide these habitat components.

Under the Proposed Action Reclamation would:

- September 15 through October 31: Operate the Suisun Marsh Salinity Control Gates (SMSCG) up to 45 days cumulatively to maintain salinity of 6ppt or less at Belden's Landing based on a 14-day average; and,
- September 1 through October 31: Maintain X2 at a monthly average of 80 km.

During September and October, the Proposed Action would provide low salinity habitat in the lower Sacramento River, Suisun Bay, and Suisun Marsh into Honker Bay and portions of Grizzly Bay.

Suisun Marsh Salinity Control Gate Action
The SMSCG would be operated on the tidal cycle for up to 45 days cumulatively during September 15 – October 31 of 2019. If temperatures are at or above 25°C, as measured at either station, throughout the Suisun Marsh (CDEC: BDL), Goodyear Slough (CDEC: GYS), the SMSCG operation would cease. It is proposed that the SMSCG would have increased tidal operations to direct more fresh water in Suisun Marsh, which is intended to reduce salinities in Suisun Marsh, increase food, and improve habitat conditions for Delta Smelt in the region.

In 2018, effects of gate operations were observed to last longer than the actual operation itself. Therefore, the gates may be operated intermittently to achieve the objectives. Gate operations would be based on real-time monitoring combined with information from studies in previous years to achieve the desired low salinity zone habitat conditions in Suisun Marsh. Delta outflow would be provided by the projects to meet the prevailing D-1641 standards. It is hypothesized that operating the SMSCG will promote low salinity habitat in Suisun and Grizzly bays during the fall. This action will not result in any migration impediments for other species, but it is uncertain how changing salinity will alter local fish communities. Associated with the Proposed Action, biological and habitat monitoring will occur to inform Adaptive Management.

Specifically, Reclamation seeks to enhance ongoing fisheries monitoring programs including California Department of Fish and Wildlife (CDFW) Summer Townet survey, USFWS EDSM Kodiak Trawl, and UC Davis Suisun Marsh otter trawl survey if funding is available. The goal of supplementing these monitoring programs is to increase the temporal and spatial resolution of

the fisheries data they generate. These data can be used to quantify the effects of the Proposed Action.

Section 3 Affected Environment and Environmental Consequences

This section describes the affected environment and evaluates the environmental consequences that may occur with implementation of the Proposed Action and the No Action Alternative. Potential impacts on several environmental resources were examined and found to be minimal or nonexistent. Impacts to these resources would be similar to those in the LTO EIS and include: Air Quality and Greenhouse Gas Emissions (Chapter 16); Geology and Soil Resources (including Seismicity and Subsidence) (Chapter 11); Socioeconomics (Chapter 19); Recreation Resources (Chapter 15); Land Use (Chapter 13); and Agriculture (Chapter 12).

Potential impacts on several environmental resources not evaluated in detail in the LTO EIS were also found to have minimal or nonexistent impact: Aesthetic Resources; Hazards and Hazardous Materials; Noise; Transportation; and Utilities, Public Services, and Service Systems. This is because the Proposed Action would be temporary, is within the current normal operating ranges, and would not results in new construction or ground-disturbing activities. Therefore, these environmental resources are not evaluated in detail in this EA.

Cultural Resources: The Proposed Action would be temporary and is within the current normal operating ranges and would not have significant impacts to historic properties. This type of undertaking does not have the potential to cause effects to historic properties, should such properties be present, pursuant to Title 54 U.S.C. § 306108, commonly known as Section 106 of the National Historic Preservation Act (NHPA) regulations codified as 36 CFR § 800.3(a)(1). There would be no new construction or ground-disturbing activities and no changes in land use because of this action. Reclamation has no further obligations pursuant to NHPA Section 106, CFR § 800.3(a)(1).

Indian Trust Assets: The Proposed Action does not have a potential to affect Indian Trust Assets (ITA), which are legal interests in assets that are held in trust by the U.S. for federally recognized Indian tribes or individuals. The closed ITA is Lytton Rancheria, which is approximately 27 miles southwest of the project area. There would also be no new construction or ground-disturbing activities and no changes in land use as a result of this action. Based on the nature of the planned work it does not appear to be in an area that will impact Indian hunting or fishing resources or water rights nor is the proposed activity on actual Indian lands. For these reasons, it is reasonable to assume that the proposed action will not have any impacts on ITAs.

Indian Sacred Sites: The Proposed Action does not have a potential to affect Indian Sacred sites as defined in Executive Order 13007 (May 24, 1996). There would be no new construction or ground-disturbing activities and no changes in land use as a result of this action; therefore, this project would not inhibit use or access to any Indian Sacred Sites.

Environmental Justice: Executive Order 12898 requires each Federal agency to identify and address disproportionately high and adverse human health or environmental impacts, including social and economic effects of its program, policies, and activities on minority populations and low-income populations. There would be no new construction or ground-disturbing activities and no changes in land use as a result of this action; therefore, the Proposed Action would not result in adverse human health or environmental impacts to minority or low-income populations.

This EA will analyze the affected environment of the Proposed Action compared to the No Action Alternative in order to determine the potential impacts and cumulative effects. This analysis will be completed for the following environmental resources: 1) Water Resources and 2) Biological Resources.

3.1 Water Resources

3.1.1 Affected Environment

The affected environment for water resources is further described in the LTO EIS Chapter 5: Surface Water Resources and Water Supplies and Chapter 6: Surface Water Quality. The LTO EIS (Section 5.4.3.1 and Appendix 5A) includes Fall X2 analysis following a Wet Year (74 km) and following an Above Normal Year (81 km) (LTO EIS Appendix 5A Section C-15). Table C-15-1-1 in Appendix 5A of the LTO EIS compares the implementation of Action 4 (LTO EIS No Action Alternative) to not implementing Action 4 (LTO EIS Alternative 1). In the LTO EIS Table C-16-1 (X2, End of Month Position), the average X2 position projected to the year 2030 was 73.9 km for a Wet Year, 81.0 km for an Above Normal Year, 89.1 km for a Below Normal Year, 91.5 km for a Dry Year, and 93.6 km for a Critical Year.

Hydrology

In addition to the 2008 BO Action 4, the SWRCB D-1641 includes two Delta outflow criteria. A Net Delta Outflow Index is specified for all months in all water year types. A "spring X2" Delta outflow is specified from February through June to maintain freshwater and estuarine conditions in the western Delta to protect aquatic life. The criteria require operations of the CVP and SWP upstream reservoir releases and Delta exports in a manner that maintains a salinity objective at an X2 location. The spring X2 standard was established to improve shallow water estuarine habitat in the months of February through June and relates to the extent of salinity movement into the Delta. The location of X2 is important to both aquatic life and water supply beneficial uses, as Delta agricultural users require freshwater at their diversions. Figure 2 shows the locations of Collinsville and Mallard Slough, which represent approximately 81 and 74 km from Golden Gate, respectively.

X2 also affects Joint Point of Diversion (JPOD). All JPOD diversions under excess conditions in the Delta are junior to Contra Costa Water District water right permits for the Los Vaqueros Project and must have an X2 location west of certain compliance locations consistent with the 1993 Los Vaqueros BO for Delta Smelt.

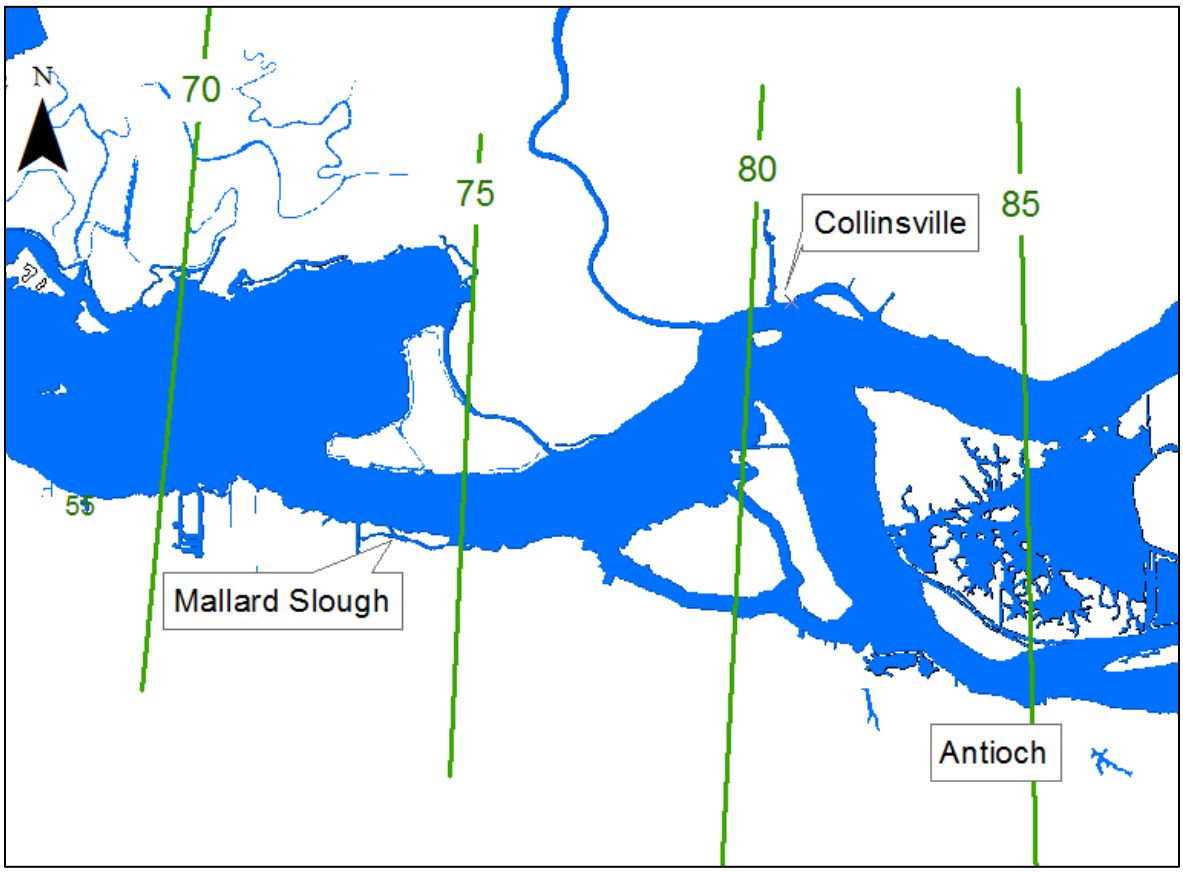

Figure 2. Distance (km) from the Golden Gate for Mallard Slough and Collinsville

Water Quality

Salinity is commonly measured in units of electrical conductivity (EC) or total dissolved solids (TDS). It also can be measured in psu or ppt. Salinity in the Delta can affect water quality for drinking water and non-potable uses such as industrial processes, irrigation, groundwater recharge, and water recycling. Changes in operation of the CVP and SWP can alter levels of salinity in the Delta.

The LTO EIS utilizes Delta Simulation Model II (DSM2), a one-dimensional hydrodynamic and water quality simulation model, to evaluate changes in salinity and CalSim II outputs to evaluate changes in the location of X2 in the Delta (described in Appendix 5A of the LTO EIS).

The LTO EIS analyzed operation of the CVP and SWP with and without Action 4 of the 2008 BO. The average September through December X2 position in km modeled in CalSim II was used to evaluate changes in salinity and other factors under the alternatives in the LTO EIS (Section 6.4.3.1). Results indicate that under Action 4 in the 2008 BO, the X2 position would range from 75.9 km to 92.4 km, depending on the water year type, with a long-term average X2 position of 84 km (Section 9.4.3.1, page 9-204). CalSim II results indicate that without Action 4 of the 2008 BO, the X2 position would range from 85.6 km to 92.3 km, depending on the water year type, with a long-term average X2 position of 88.1 km (page 9-343), a location that does not

provide for the advantageous overlap of the low salinity zone with Suisun Bay/Marsh. The most eastward location of X2 is predicted under Critical water year conditions. The X2 positions predicted in the LTO EIS with and without Action 4 of the 2008 BO Fall X2 prescription would be similar in drier water year types. In wetter years (Above Normal and Wet Year types), the X2 location would be further west under Action 4 of the 2008 BO by 6.1 to 9.8 km than without the 2008 BO in the LTO EIS (page 9-204).

3.1.2 Environmental Consequences

No Action Alternative

Under the No Action Alternative, Reclamation would maintain a monthly average X2 of 74 km in September and October and would not implement the Proposed Action for Delta Smelt habitat in 2019. Impacts to water resources would be the same as described in the LTO EIS (Chapter 5). The forecasted location of X2 under the No Action Alternative is estimated to be no more eastward than 74 km under all scenarios (Table 1). The forecasted outflow for October is estimated to be approximately 12,750 cfs. Additional estimated forecasted outflows for Fall 2019 can be found in Appendix B.

Proposed Action

Hydrology

The Proposed Action would be no more eastward than a monthly average of 80 km.

DWR ran DSM2 modeling showing the forecasted daily X2 location (Figure 3). DWR also ran additional modeling on 50 percent and 90 percent exceedance forecasts to determine storage, outflow, and exports for the months of September through December (Appendix B).

Table 1. Monthly Mean X2 from Mean Daily Forecast, September – November 2019

Month	No Action (50% Exceedance)	Proposed Action (50% Exceedance)	No Action (90% Exceedance)	Proposed Action (90% Exceedance)
September	74	80	74	80
October	73	79	74	80

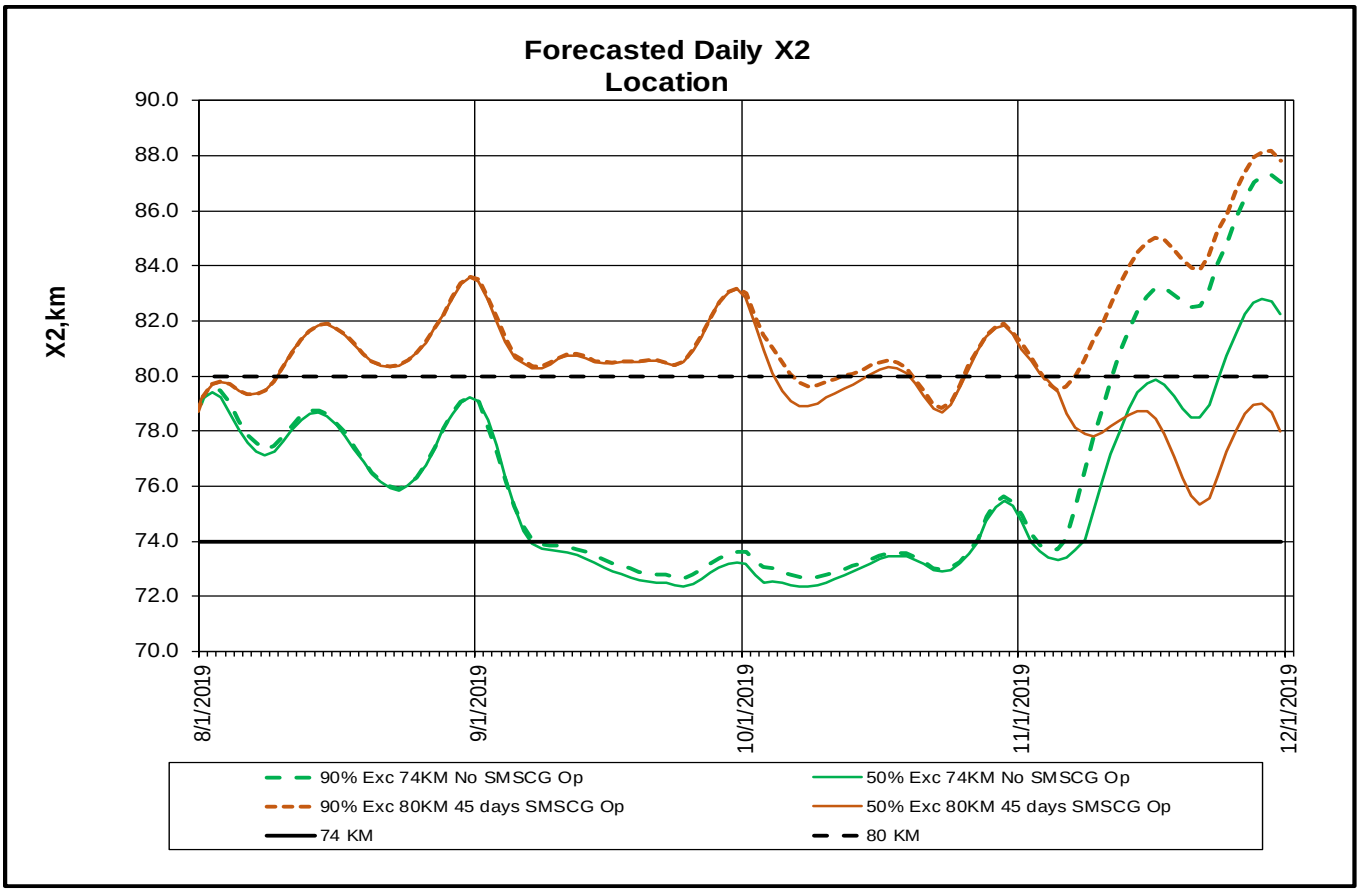

Figure 3. Forecasted Daily X2 Location

According to the analysis provided by DWR (Appendix B), end of Month Storage at Shasta, Folsom, and Oroville reservoirs would differ between the Proposed Action and the No Action Alternative for the months of September through December. Under the 50% and the 90% exceedance, these changes are all beneficial (higher storage) except for when they are the same, likely due to flood control constraints. Upstream reservoir releases and storage are expected to be managed by needs for flood control operations and other downstream needs.

As described in Tables 2 and 3 and Appendix B, the Proposed Action is estimated to result in approximately 97 thousand acre feet (TAF) of additional water stored in San Luis (State) (960 TAF – 863 TAF) at the end of November as compared to the No Action Alternative, under the 50% exceedance. The Proposed Action is estimated to result in approximately 26 TAF (416 TAF – 390 TAF) additional water stored at the end of November in San Luis (Federal) under the 50% exceedance. Therefore, the Proposed Action would have beneficial impacts to downstream storage under the 50% exceedance. Under the 90% exceedance, the State has 95 TAF less storage in San Luis in November, about a 10% reduction, but more than 200 TAF more water in Oroville Reservoir, between the Proposed action and the No Action Alternative.

The computed outflow (Appendix B) for September and October under the 80 km plus SMSCG is 9,500 cubic feet per second (cfs) and 10,600 cfs (50% exceedance), respectively. Under the No

Action Alternative (74 km) the computed outflow for September and October would be 14,000 cfs and 12,750 cfs (50% exceedance), respectively. An X2 location of 80 km plus SMSCG is estimated to result in no greater than 4,500 cfs (about 32%), and 2,150 cfs (about 17%) decreased outflow in the Delta for the months of September and October compared to the No Action Alternative.

Table 2. End of Month Storage in San Luis (State) (TAF) (50% exceedance)

Month	No Action (74 km)	Proposed Action (80 km)
September	923	923
October	816	730
November	863	960

Table 3. End of Month Storage in San Luis (Federal) (TAF) (50% exceedance)

Month	No Action (74 km)	Proposed Action (80 km)
September	283	283
October	210	236
November	390	416

Refer to Table 4 (No Action) and Table 5 (Proposed Action) for a summary of changes between monthly average releases from Shasta, Folsom, and Oroville dams. The data shows mixed results. In some situations, for example September releases for Oroville, there is a large drop in releases from No Action compared to the Proposed Action. Whereas for the month of October, there is an increase in releases from Folsom for the Proposed Action as compared to the No Action (Appendix B).

Table 4. No Action Alternative Monthly Average Releases from Shasta, Folsom, and Oroville dams (cfs) (50% exceedance)

Month	Shasta	Folsom	Oroville
September	8,750	3,150	10,500
October	8,000	2,500	4,250
November	5,350	4,050	2,450

Table 5. Proposed Action Alternative Monthly Average Releases from Shasta, Folsom, and Oroville dams (cfs) (50% exceedance)

Month	Shasta	Folsom	Oroville
September	7,500	2,500	7,850
October	4,000	3,300	4,350
November	9,800	5,750	2,450

Water Quality

DWR ran DSM2 modeling showing the forecasted daily EC at Collinsville, CA and Mallard Slough. Collinsville and Mallard Slough represent approximately 81 and 74 km from Golden Gate, respectively (Figure 2).

D-1641 includes water quality requirements for a range of beneficial uses. Requirements at Contra Costa's pumping plant, the Jones and Banks pumping plants, North Bay Aqueduct Intake and City of Vallejo Intake are set for municipal and industrial beneficial uses. The maximum mean daily Chloride concentration in milligrams per liter (mg/l) is not allowed over 250 mg/l in all water year types and in all years. At Contra Costa Canal at Pumping Plant #1 or San Joaquin River at the Antioch Water Works Intake, the maximum mean daily chloride concentration is not allowed over 150 mg/l for between 155 and 240 days per calendar year, depending on water year type.

Most of D-1641's agricultural water quality objectives only apply from April 1 to August 15 at the latest. Southern Delta and Export Area requirements apply during October. Several San Joaquin River and Old River locations have maximum 30-day running average EC of 1 millimhos per centimeter (mmhos/cm), or 1000 micromhos per centimeter (umhos/cm) in October in all water year types. The West Canal at the mouth of Clifton Court Forebay and the Delta Mendota Canal at the Tracy Pumping Plant have requirements of 1000 umhos/cm all year and in all water year types.

In D-1641, Collinsville has an EC objective of 19 mmhos/cm for October for fish and wildlife beneficial uses, based on the maximum monthly average of both daily high tide EC values. This is equivalent to 1900 umhos/cm.

Based on results presented as part of the Delta Smelt Fall Outflow Environmental Assessment in 2017 (Reclamation 2017), available CDEC data suggests Fall X2 has little potential influence on mean water temperature in September, October, or November at various Delta stations. This is consistent with general observations from the Delta that flow does not greatly affect temperature (Kimmerer 2004; Wagner et al. 2011).

3.2 Biological Resources

3.2.1 Affected Environment

The affected environment for biological resources in the Delta is further described in the LTO EIS Chapter 9: Fish and Aquatic Resources and Chapter 10: Terrestrial Biological Resources.

Delta Smelt

Delta Smelt was listed as threatened on March 5, 1993 (58 Federal Register [FR] 12854). The species has been proposed for re-listing as endangered under the ESA. The up-listing was found warranted-but-precluded on April 7, 2010 (75 FR 17667). Additional information on the status of Delta Smelt, including long-term abundance trends and spatial distribution can be found in Appendix O of the 2019 EIS for the Reinitiation of Consultation (ROC) on the Coordinated Long-Term Operations (LTO) of the CVP and SWP. As stated in the Background Section of this document, the 2008 BO set forth an RPA with actions that allow for continued operation of the CVP and SWP without jeopardizing and adversely modifying Delta Smelt or its critical habitat.

Action 4 is described in the 2008 BO as:

> *This action is designed to increase baseline monthly outflows in the fall period of wet and above normal WYs to increase areas of habitat and move the habitat away from Delta impacts and into broader open waters west of Sherman Island; and to increase variability of monthly habitat extent by having 2-3 months above the baseline. This would be expected to distribute smelt into more diverse geographic areas, helping to reduce the risk of localized losses from future entrainment, contaminants, and predation. Finally, it may reduce the proliferation of other factors that reduce habitat suitability such as Microcystis and Egeria growth.*

The justification for Action 4 goes on to say:

> *The action is focused on wet and above normal years because these are the years in which project operations have most significantly adversely affected fall (Figure E-27 in Effects section) and therefore, actions in these years are more likely to benefit delta smelt.*

In addition to the environmental and biological goals listed above, and in understanding the analysis and compliance with the existing 2008 BO, the Proposed Action shall focus on meeting the objectives of Action 4 by considering the Primary Constituent Elements (PCEs) of Delta Smelt critical habitat:

1. Physical habitat for spawning
2. Suitable water quality for all life stages
3. River flow
4. Salinity for rearing

The 2008 BO indicates that low salinity habitat is important to the species and requires maintaining low salinity habitat west of the Sacramento-San Joaquin confluence in the fall of

Wet and Above Normal water years. The 2008 BO does not attach importance to a particular location of LSZ habitat, other than comparisons with historical ranges (Figures E-19 and E-25 in 2008 BO). The 2008 BO indicates that the size of low salinity habitat is constrained or reduced when X2 is upstream of approximately 81 km, as that is the approximate location of an inflection point, above which the majority of the low salinity zone moves upstream of shallow bays into the channelized areas of the Delta.[iii]

The Proposed Action meets the biological goals of Action 4 of the 2008 BO RPA because it would provide low salinity habitat in Suisun Marsh and portions of Suisun Bay, which is within the species' fall range. The Proposed Action provides a greater quantity of low salinity habitat as compared to when X2 is at the inflection point of 81 km. When X2 is at 81 km, there are approximately 13,128 acres of low salinity habitat in the species fall range in August and September.[iv] Operating to X2 at 80 km with the SMSCG provides approximately 16,120 acres of low salinity habitat in the species fall range (based on 2018 UnTRIM modeling of the SMSCG action). The Proposed Action meets the biological goals of Action 4 because it will provide more low salinity habitat than would be provided if X2 were at the inflection point of 81 km.

The 2008 BO relied on a Delta Smelt stock-recruitment model published by Feyrer *et al.* 2007 to predict whether a change in the quantity of fall low salinity habitat would result in increased smelt recruitment. While the biological appropriateness of the model has been questioned;[v] if the model were applied to a change in X2 from 74 km to 80 km, the model shows an approximately equal chance of observing an increase or decrease in smelt recruitment.[vi] When the National Research Council reviewed the 2008 BO, they also observed that the data showed:

> "delta smelt can be successful even when habitat is restricted."[vii]

These results are consistent with the agencies' FLaSH and Flow-Alteration-Management, Analysis, and Synthesis Team (FLOAT-MAST) Reports, which have not found that Delta Smelt abundance consistently increases in wet years, rather changes in species abundance are likely driven by a broad suite of environmental and biological factors beyond water-year type. The Proposed Action meets the biological goals of the BO because it will provide approximately the same probability of increased species abundance as the No Action Alternative.

Freshwater flow does not increase the growth rate of the Delta Smelt's primary fall food supply, *Pseudodiaptomus forbesi*.[viii] This finding is consistent with the FLOAT MAST report that did not find a difference in phytoplankton biomass in fall 2017, which was a wet year.[ix] There are regional differences in food availability in the Delta Smelt's fall range; however, food availability is generally better in Suisun Marsh and the lower Sacramento River as compared to Suisun Bay.[x] The Proposed Action meets the biological goals of the 2008 BO because it will provide low salinity habitat in Suisun Marsh, an area where food supplies are generally better.

Microcystis is generally lower in wet years as compared to dry years.[xi] However, the response of *Microcystis* to outflow or X2 has not been consistent from year to year.[xii] The reason for the inconsistent response is likely because X2 and outflow are not the sole or primary drivers of *Microcystis* abundance.[xiii] The Proposed Action meets the biological goals of the 2008 BO because *Microcystis* should generally be lower in 2019 because it is a Wet year and therefore

conditions should be generally better under either approach. Since neither outflow nor X2 appear to be the primary drivers of *Microcystis* abundance, the abundance of *Microcystis* should be similar under either the proposed or No Action Alternative.

The 2008 BO hypothesized that additional fall flows would dilute contaminants.[xiv] However, studies have found that contaminants are not necessarily diluted in wet years as high flows can mobilize contaminated sediments.[xv] In 2017, a wet year, ammonia was not diluted and concentrations in the Delta were at levels that could have inhibited diatom (Delta Smelt food supply) growth. At the same time, there appears to be regional differences in contaminants. Delta Smelt in Suisun Marsh appear less stressed by contaminants than in Suisun Bay and Cache Slough.[xvi] The Proposed Action meets the biological goals of the 2008 BO as it will provide low salinity habitat in the portion of Delta Smelt's range where the species appears less stressed by contaminants - Suisun Marsh.

The 2008 BO hypothesized that additional fall flows would reduce the abundance of clams that compete with Delta Smelt for its food supply.[xvii] However, higher flows only appear to change the species of clam from the species that prefers brackish conditions to the species that prefers freshwater conditions.[xviii] Both species consume the same prey as Delta Smelt.[xix] Therefore, the Proposed Action meets the biological goals of the 2008 BO because it would affect the clam abundance to the same extent as the No Action Alternative.

Delta Smelt Stock-Recruit Model Fitting Results and Discussion

Between 2005 and 2018, the Fall Mid-water Trawl (FMWT) index in all but one year (2011) was lower than any year in the original 1987-2004 data used by Feyrer et al. (2007) (Figure 4a). During 2005-2018 recruitment to the Summer Tow Net (STN) index was within the 1987-2004 range, with the exception of 2012 and 2015 (corresponding to the 2011 and 2014 fall X2 and FMWT index) which were the lowest on record going back to 1969 and 2011, which was the third highest. The years 2005–2018 spanned a historically dry hydrologic period, yet fall X2 was within the range observed between 1987–2004 (Figure 4b). Only water years 2005, 2011, and 2017 met the criteria to trigger fall X2 compliance in the following water year, and only 2011 and 2017 occurred after the 2008 BO was implemented (Figure 4, red points).

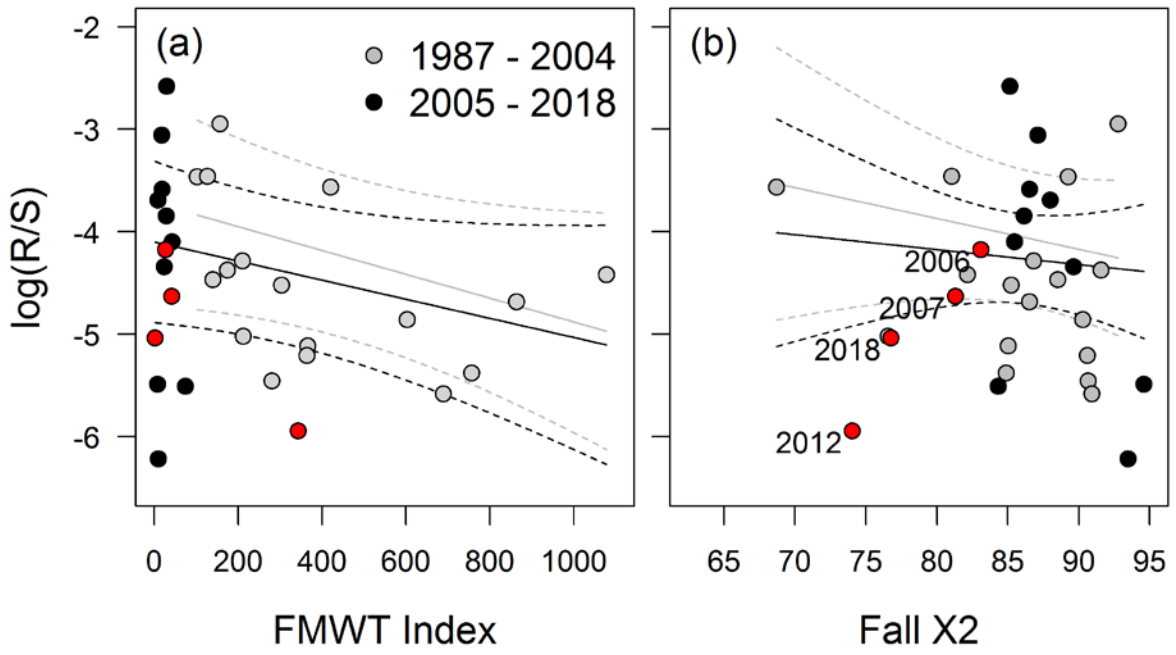

Figure 4. The selected juvenile recruitment model fit to the fall midwater trawl index (a) and mean location of X2 in the months from September to December.

Notes: (a) fall X2 was fixed at 75 kilometers upstream of the Golden Gate. For (b) the FMWT index was fixed at 2 to illustrate the effect of fall X2 in the absence of density dependence. Points in red indicate the years following the Above Normal and Wet water years that trigger RPA Action 4 in the 2008 BO requiring X2 to be located at or downstream of 81 and 74 kilometers. Note that year labels reflect the summer recruitment year, i.e., the summer following the fall used to predict survival.

The general fall X2–recruitment correlation reported in Feyrer et al. (2007) has not changed with the addition of 14 years of new data: there is still a negative effect of both FMWT index and fall X2 on recruitment (Figure 4). A negative effect indicates that recruits per spawner are expected to decline as the FMWT index or fall X2 increase. However, model selection identified the model with only the spawning stock S variable (FMWT index) as the best model for both the 1987–2004 and 1987–2018 data. For the original data the 2008 BO-adopted model was ranked fourth out of the five models considered (Table 6), but still has substantial support based on Akaike Information Criteria (Burnham and Anderson 2002; $\Delta_{AICc} = 2.3$). The evidence ratio ($exp^{-1/2.\Delta AIC}$) for the 2008 BO-adopted model is 3.1; that is, evidence is 3.1 stronger for the spawning stock only model relative to the 2008 BO-adopted model (Burnham et al. 2011). Including the additional 14 years of data did not change the model rank, and relative support for the 2008 BO-adopted model changed only marginally (Table 7.; $\Delta_{AICc} = 2.4$; evidence ratio = 3.3). Further, when considering the additional 14 years of data the effect size of fall X2 is smaller and more uncertain (95% C.I. includes 0; Figure 5).

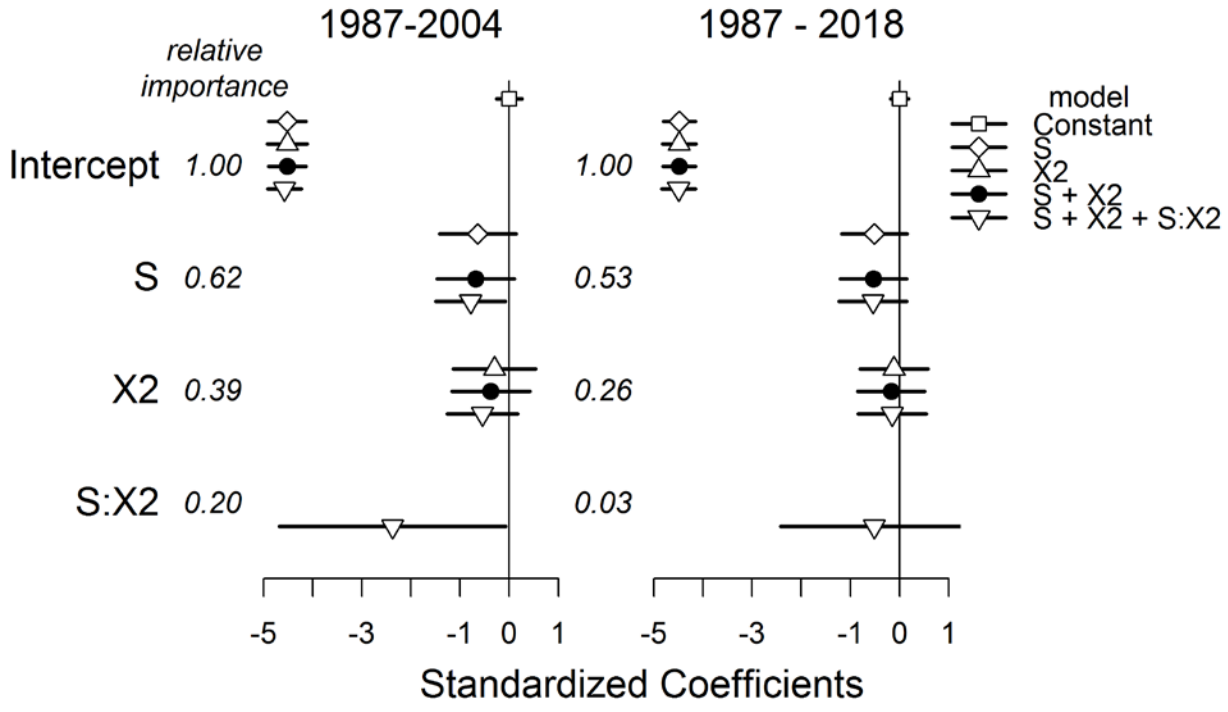

Figure 5. Regression coefficients for the five models fit to the original data used in Feyrer et al. 2007 (1987–2004) and updated data (1987–2018).

Notes: To aid interpretation of the regression coefficients the scale of the input variables are standardized by subtracting their mean and dividing by two standard deviations (Gelman 2008). The model selected in Feyrer et al. 2007 and adopted in the 2008 BO is represented by the filled circle. Lines represent the 95% confidence intervals on the coefficient estimates. Relative importance—the support for individual parameters—is the summed AICc weights of models that include the parameter.

The evaluated models fail to explain much of the variation in the original and updated data. The best model explains only 11% of the observed variance in the original data compared to 12% the 2008 BO adopted model explains (Table 6); the same models explain 5% and 2% of the variance in the updated data (Table 7). In all cases the adjusted R^2 is considerably lower than the top model reported in Feyrer et al. (2007) (adjusted $R^2 = 0.60$), likely due to using the biologically appropriate multiplicative model rather than the additive model used in Feyrer et al. (2007). Any differences in variance explained by the models here were not reflected in differences in the expected prediction error. The prediction error for all five models is expected to be 16-19% of the mean for the original data. Prediction error is marginally worse for the five models (21-23%) when data from years 2005 through 2018 are included. Thus, we conclude the fall X2–recruitment correlation was overstated in the original analysis and the effect of fall X2 has become weaker with the addition of new data.

Table 6. Model selection for the effect of fall Stock (FMWT index) and X2 fit to juvenile recruitment (log(R/S)) using 1987–2004 data (n = 17).

Model	r.df	dAIC	Wt	adj.r2	CVrmse
S	15	0.0	0.32	0.11	0.18
Constant	16	0.2	0.29	NA	0.18
S + X2 + S:X2	13	0.9	0.20	0.31	0.16
S + X2	14	2.3	0.10	0.12	0.19
X2	15	2.5	0.09	-0.03	0.19

Table 7. Model selection for the effect of fall Stock (FMWT index) and X2 fit to juvenile recruitment (log(R/S)) using 1987–2018 data (n = 31).

Model	r.df	dAIC	Wt	adj.r2	CVrmse
S	29	0.0	0.38	0.05	0.21
Constant	30	0.1	0.36	NA	0.21
X2	29	2.4	0.11	-0.03	0.22
S + X2	28	2.4	0.12	0.02	0.22
S + X2 + S:X2	27	4.9	0.03	-0.00	0.23

The models presented herein are analogous to those used by Feyrer et al. (2007) and USFWS (2008), and are somewhat simplistic in that they violate certain assumptions, including independence of response and predictor variable (e.g., recruits in one time step become the stock in the following time step), ignore uncertainty in the stock and recruit indices, and do not address whether juvenile recruitment is the life-stage transition limiting Delta Smelt population productivity. Recently, more sophisticated methods have been employed to evaluate what effect fall X2 has on the Delta Smelt population trends. For example, studies using Bayesian change point analysis (Thomson et al. 2010) and multivariate autoregressive modeling (Mac Nally et al. 2010) both failed to identify fall X2 as an environmental covariate contributing to the declining abundance trends in Delta Smelt. State-space multistage life-cycle models (e.g., Maunder and Deriso 2011) consider multiple factors acting on different life-stages, including environmental covariates and density dependence. Development of such life-cycle models for Delta Smelt is ongoing (K. Newman, R. Deriso, personal communication to C. Phillis), but ultimately should be capable of assessing the influence of fall X2 on Delta Smelt population dynamics relative to factors affecting other life stages.

We are reliant on the analysis presented above to evaluate the effects of X2 position on stock-recruitment of Delta Smelt although we recognize the fall X2 environment-recruitment correlation does not reliably predict recruitment from the adult index (FMWT) to the juvenile index (STN). This finding does not invalidate work by others hypothesizing fall X2 predicts the quality and quantity of Delta Smelt habitat (Feyrer et al. 2007; Feyrer et al. 2011); however, the analysis herein and work by others (Mac Nally et al. 2010; Thomson et al. 2010; Miller et al. 2012) have failed to detect a significant population-level response to changes in habitat associated with fall X2.

Application to Proposed Action

The preceding model fitting of Delta Smelt juvenile recruitment in relation to adult stock size and fall X2 suggests that large changes in fall X2 would be necessary to provide a greater probability of an increase in recruitment (for additional information refer to Appendix A). The Proposed Action would give X2 of 80 km in September and October.

The simulation framework for the coefficients and associated confidence intervals developed for Equation 4 (Appendix A) (i.e., the model analogous to Feyrer et al. 2007) using the 1987-2018 data were applied to September- October X2 of 80 km compared to 74 km to illustrate potential effects of the Proposed Action. This suggested that moving mean September-October X2 from 80 km to 74 km would be unlikely to have a measurable effect on Delta Smelt recruitment in 2020: with increases in survival in around half of simulations, decreases in the other half, and similar percentages of simulations with halving or doubling of survival (Figure 6).

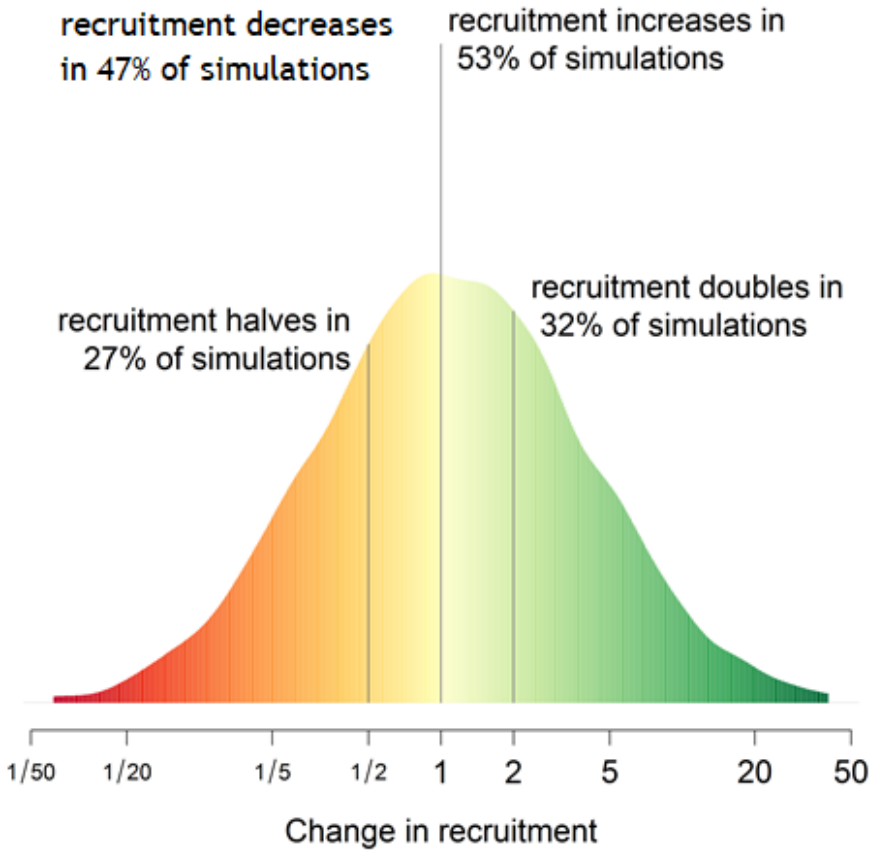

Figure 6: Posterior Density Distributions from 10,000 Simulations of the Change in Delta Smelt Fall to Summer Recruitment when Mean September-October X2 is Moved from 80 km to 74 km.

Salmonids

For the purposes of this analysis, threatened Central Valley spring-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), endangered Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), and threatened California Central Valley steelhead Distinct Population Segment (DPS) (*Oncorhynchus mykiss*) are described collectively as salmonids. Salmonids pass through the Delta and Suisun Marsh as adults migrating upstream and juvenile outmigrating downstream. However, fish catch data (2000-2017) from the California Department of Fish and Wildlife Summer Townet, and fish catch data (2000-2015) from the University of California, Davis (UC Davis) Suisun Marsh survey document the catch of zero juvenile Chinook salmon (*Oncorhynchus tshawytsacha*) (of any run-type) for the months of July and August over the last 15-17 years at their Suisun Marsh survey/ sampling stations. The only salmonid captured was a single Steelhead (*0. mykiss*) in September of 2014, by the UC Davis survey. studies have shown that 55-70 % of the adult salmonids arriving at the SMSCG pass the structure during typical periods of operation (October - May) (NMFS BO, page 435).

Critical Habitat

The federal ESA requires that the Service and NMFS designate critical habitat for species listed as federally endangered or threatened. "Critical habitat" is defined in ESA as: (1) specific areas within the geographical area occupied by the species at the time of listing, if they contain physical or biological features essential to a species' conservation, and those features may require special management considerations or protection; and (2) specific areas outside the geographical area occupied by the species if the agency determines that the area itself is essential for conservation (16 USC 1531 et seq). Critical habitat has been designated for the following located within the project area:

- Delta Smelt (56 FR 65256)
- Central Valley spring-run Chinook salmon ESU (70 FR 52488)
- Sacramento River winter-run Chinook Salmon ESU (58 FR 33212)
- California Central Valley steelhead DPS (70 FR 52488)

Delta Smelt

Recent guidance has been issued by the Service to move towards physical and biological features in relation to critical habitat; however, PCEs were evaluated to ensure consistency with the 2008 BO. In designating critical habitat for Delta Smelt, the Service identified the following physical or biological features, described as PCEs in the 2008 BO, essential to the conservation of Delta Smelt (DS-PCE): (DS-PCE1) suitable substrate for spawning; (DS-PCE2) water of suitable quality and depth to support survival and reproduction (e.g., temperature, turbidity, lack of contaminants); (DS-PCE3) sufficient Delta flow to facilitate spawning migrations and transport of larval Delta Smelt to appropriate rearing habitats; and (DS-PCE4) salinity, which influences the extent and location of the low salinity zone where Delta Smelt rear.

Critical habitat for Delta Smelt includes all water and submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained in the

legal Delta (as defined in Section 12220 of the California Water Code) (USFWS 1994). Additional information on Delta Smelt Critical Habitat can be found in Appendix O of the 2019 EIS for the ROC on the Coordinated LTO of the CVP and SWP.

Salmonids

Anadromous Salmonid PCEs (AS-PCE) of critical habitat are similar and are essential for supporting one or more life stages of each ESU or DPS (spawning, rearing, migration, and foraging). PCEs specific to the Delta include (AS-PCE3) unobstructed freshwater migration corridors with sufficient cover and water quantity and quality suitable for juvenile and adult movement and survival; and similarly (AS-PCE4) estuarine areas free of obstruction and excessive predation. Additional information on Salmonid Critical Habitat in Appendix O of the 2019 EIS for the ROC on the Coordinated LTO of the CVP and SWP.

3.2.2 Environmental Consequences

No Action Alternative

Under the No Action Alternative, Reclamation and DWR would not implement an adaptively managed fall outflow for Delta Smelt in 2019 and would maintain a monthly average X2 of 74 km in September and October. Impacts to biological resources would be the same as described in the LTO EIS (Chapters 9 and 10).

Proposed Action

The environmental consequences for biological resources in the Delta are further described in the LTO EIS Chapter 9: Fish and Aquatic Resources (Sections 9.4.1.3 and 9.4.3.1) and Chapter 10: Terrestrial Biological Resources (Sections 10.4.1 and 10.4.3). The No Action Alternative in this EA is represented by Action 4 of the 2008 BO in the LTO EIS (Section 3.3.2 and Appendix 3A). The Proposed Action would alter upstream storage and releases and would alter instream flows upstream of the Delta.

In addition, impacts from the Proposed Action would impact Delta outflow due to south of Delta exports. The Delta outflow for the months of September and October will be decreased as part of the Proposed Action compared to the No Action Alternative (Appendix A for data and additional detail on Proposed Action Delta outflow forecasts). The Delta outflow changes are confined to the months of September and October. The Proposed Action would adversely affect Delta Smelt critical habitat, specifically river flow affecting the extent and salinity influencing the location and extent of the LSZ (DS-PCE4). However, the Proposed Action would not adversely modify critical habitat (see below Critical Habitat section).

Delta Smelt

The Proposed Action would be no more eastward than 80 km. The 81 km prescription in the 2008 BO was designed to improve fall habitat for Delta Smelt. The Proposed Action would have an average location of 80 km, downstream of the Above Normal Water Year prescription in the 2008 BO. In 2011, X2 for the months of September and October was at approximately 74 km. Since the 2008 BO, an X2 prescription of 81 km has not been implemented. Much of the existing data looks at an X2 location of 74 km in 2011 compared to other years, in which an X2

prescription was not implemented. The LTO EIS found the X2 position ranged from 85.6 km to 92.3 km, depending on the water year type, with a long-term average X2 position of 88.1 km.

Several biotic (food) and abiotic (salinity, water clarity, and water temperature) parameters were identified as potentially important to Delta Smelt and its critical habitat. This approach is consistent with the MAST Report (IEP 2015) and 2011 FLaSH (Brown et al. 2014) investigations.

According to Reclamation's Delta Smelt Fall Outflow 2017 EA, in order to provide a greater probability of an increase in survival of Delta Smelt, large changes would be necessary to Fall X2. Under the Proposed Action, the X2 locations would be at a monthly average of 80 km in September and 79 km in October. Available forecasts suggest that X2 could be as low as 78 km in September and October under the Proposed Action.
Using lookup tables in FLaSH (Table 2-1 in Brown et al. 2014) an X2 of 74 km would give an LSZ area of approximately 8,408 hectares (20,777 acres) and X2 location of 80 would give a LSZ area of approximately 6,653 hectares (16,440 acres). An X2 location of 80 km would be approximately 21% less LSZ area than 74 km. It is important to note that this is likely an overestimate because it does not include the SMSCG.

In addition, using lookup Table 3-1 in FLaSH (Brown et al. 2014) an X2 location of 74 km would give an approximate abiotic habitat index of 7,261; whereas X2 location of 80 km would give an approximate predicted habitat index of 5,292. Compared to 74 km, an X2 of 80 km would give an approximately 27% lower abiotic habitat index.

Studies since 2008 (Mac Nally et al. 2010; Thomson et al. 2010; Miller et al. 2012) did not find a significant population-level response to changes in habitat associated with Fall X2. These studies, as well as Maunder and Deriso (2011) show that recruitment is based on a variety of factors acting on different life-stages.

The UnTRIM Bay-Delta model analysis in 2017, along with analysis in 2011 by Feyrer, show effects from the location of X2 are not linear. The UnTRIM model showed a change in salinity between 80 and 81 km. As described in Bever et al (2016), Grizzly Bay and Honker Bay are key regions for Delta Smelt. An X2 location of 80 km results in parts of Grizzly Bay and all of Honker Bay remaining at salinities favorable to Delta Smelt for 100% (Delta Smelt Outflow in 2017).

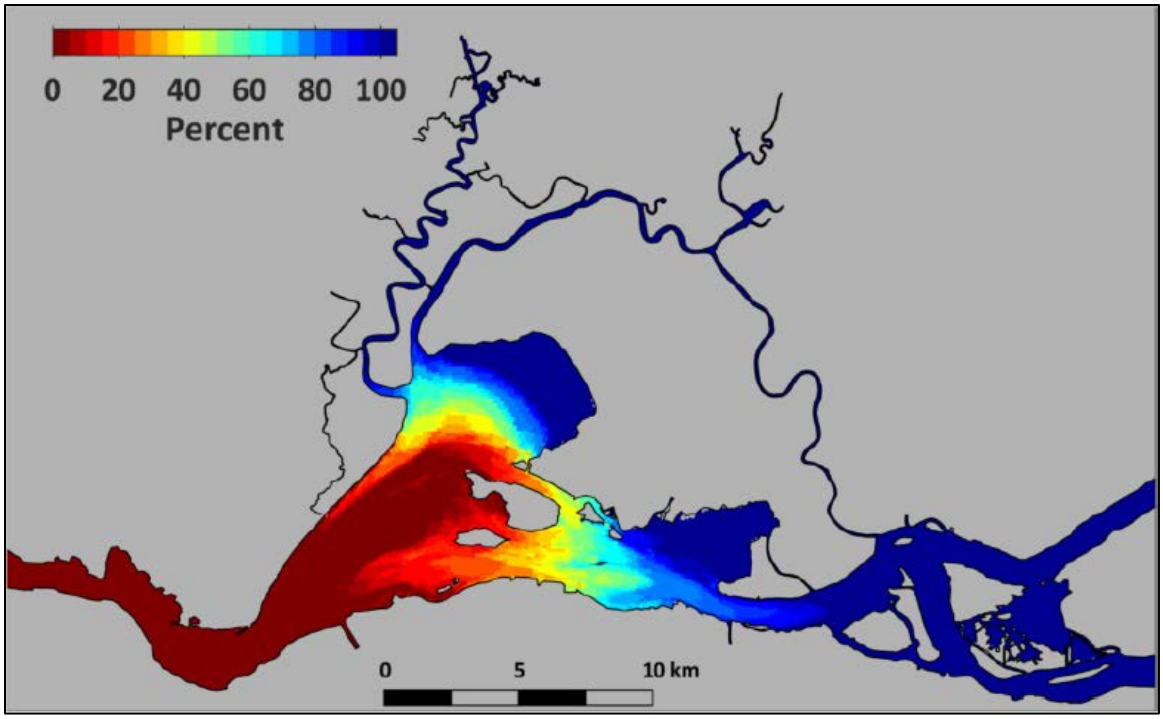

Figure 7. Percentage of time with salinity <6 for X2 = 80 km.

Salmonids

The Delta includes corridors for juvenile and adult migration (PFMC 2003). As described above the forecasted outflow under the Proposed Action in September is 9,500 cfs (in both the 50% and 90% exceedance) and is 10,600 in October (in both the 50% and 90% exceedance). Under the No Action Alternative, the forecasted outflow for September is 14,000 cfs for 50% exceedance and 13,450 cfs for 90% exceedance. Under the No Action Alternative, the forecasted outflow for October is 12,750 cfs (in both the 50% and 90% exceedance).

The Proposed Action compared to the No Action Alternative would affect Delta outflow, which could reduce attraction of adult salmonids migrating into the Delta and upstream. This could slow migration into and through the Delta compared to the No Action Alternative. Steelhead entering the San Joaquin River Basin appear to have a later spawning run, with adults entering the system starting in late October through December (LTO EIS page 9-61). The effect would occur primarily on salmonids migrating towards the San Joaquin River and its tributaries. However, the impacts would be temporary and limited to the month of October following a Wet Year. Flows upstream of the Delta would be altered when comparing the No Action Alternative and the Proposed Action. However, the resulting flow releases would in certain scenarios decrease and in certain scenarios increase. The Proposed Action would not alter any environmental requirements managing upstream of Delta reservoir releases and instream flows. Based on the above, the ultimate success of adult salmonids reaching the spawning areas should be unaffected. Adult migration in October typically occurs through the Delta for steelhead and fall-run Chinook salmon.

Operation of the SMSCG during September and October includes flash boards and gates that are tidally operated, such that for half of every tidal cycle (during ebb tides), the gates are open. These operations are not anticipated to affect the migration of Salmonids. The Proposed Action would hold the boat lock portion of the SMSCG structure in an open position at all times during the operation to allow opportunities for fish passage during all phases of the tidal cycle. Furthermore, previous studies have compared adult salmon passage during SMSCG operation (with the boat lock open) and non-operation. These studies have shown the rate of passage is virtually identical to the passage rate when the SMSCG is not operational (NMFS BO, page 435).

Information on the effects of the implementation of Action 4 on salmonids in the Delta can be found in the LTO EIS (Section 9.4.3.1).

Critical Habitat

Delta Smelt

Although Delta Smelt fall occurrence is often notable in the LSZ and Delta Smelt generally move upstream as the salinity field moves upstream (Sommer et al. 2011), the overall distribution occurs over a broader range of salinity than solely the LSZ (Sommer and Mejia 2013; Moyle et al. 2016).

The Proposed Action would adversely affect Delta Smelt critical habitat, specifically river flow affecting the extent and salinity influencing the location and extent of the LSZ. Therefore, the Proposed Action could affect the critical habitat currently being occupied by a large proportion of the Delta Smelt population by reducing the area of the LSZ, and its overlap with areas of relatively high turbidity and low current speed. It is possible Delta Smelt could; however, move upstream to the northern Delta.

An X2 location of 80 km results in parts of Grizzly Bay and all of Honker Bay at salinities favorable to Delta Smelt during the duration of the Proposed Action. In addition, the effects would be localized to the LSZ, the area between Collinsville and Mallard Slough. Additional information on the effects to Delta Smelt Critical Habitat can be found in the 2019 EIS for the ROC on the Coordinated LTO of the CVP and SWP.

Salmonids

Adult migration in October typically occurs through the Delta for steelhead and fall-run Chinook salmon (LTO EIS Section 9.3.4.12.1). Critical habitat PCEs for salmonids specific to the Delta include (AS-PCE3) unobstructed freshwater migration corridors with sufficient cover and water quantity and quality suitable for juvenile and adult movement and survival; and similarly (AS-PCE4) estuarine areas free of obstruction and excessive predation. As described above, the Proposed Action compared to the No Action Alternative would temporarily affect Delta outflow which could reduce adult migration cues into the Delta and potentially delay subsequent movement upstream. It is anticipated that the Proposed Action would not obstruct freshwater or estuarine corridors, would not create excessive predation, and would not substantially alter the water quantity or quality suitable for movement and survival of adult salmonids compared to the

No Action. Impacts would be temporary and limited to the months of September and October in 2019.

3.3 Cumulative Effects

Cumulative effects are impacts on the environment that result from the incremental impacts of an action when added to other past, present, and reasonably foreseeable future actions regardless of who undertakes them (40 CFR 1508.7). Such impacts can result from individually minor, but collectively significant, actions taking place over time (40 CFR 1508.8). Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the project area.

According to CEQ's cumulative impacts guidance, the cumulative impact analysis should be narrowed to focus on important issues at a national, regional, or local level. The analysis should look at other actions that have affected or could affect the same resources as the proposed action and alternatives. This analysis includes projects which have occurred or are expected to occur within the study area and area similar in scope to the Proposed Action. The cumulative effects study area is limited to the lower Sacramento River, Suisun Bay, and Suisun Marsh into Honker Bay and portions of Grizzly Bay. Also, given that this action will only take place in September and October 2019, the cumulative effects analysis is similarly limited in temporal scope. This cumulative effects section utilizes ROC on LTO EIS Appendix Y, *Cumulative Methodology*, (Table Y-1). The entirety of those projects listed on Table Y-1 were considered; however, certain projects have a more direct synergy with the Proposed Action. Below is a sub-set of those projects from Table Y-1 that were considered as more directly linked to the Proposed Action and as part of the cumulative effects analysis:

- Shasta Lake Water Resources Investigation (Shasta Dam Raise Project);
- Bay-Delta Water Quality Control Plan Update;
- Sites Reservoir Project;
- Delta Water Supply Project (Stockton);
- California EcoRestore; and
- Ecosystem Restoration Program Conservation Strategy (CDFW).

As a surrogate for the Proposed Action cumulative impacts, we looked at the past, present, and reasonably foreseeable future actions that were identified and considered in the analysis in the LTO EIS (Sections 3.5). Cumulative Effects analyses in the LTO EIS are included at the end of each chapter (e.g., Section 9.4.3.9 for Fish and Aquatic Resources). No past, present, or probable future projects were identified in the Proposed Action vicinity that, when added to project-related impacts, would result in a significant cumulative impact or be cumulatively considerable. Other projects occurring in and around the Delta, but outside of the waterway, would not be affected by changes in outflow.

3.3.1 Water Resources

No Action Alternative

The No Action Alternative would generate no changes to CVP and SWP water operations and would not impact CVP and SWP water users as compared to the LTO EIS. There are no cumulative projects that would cumulatively effect water resources beyond those disclosed in the ROC on LTO EIS. Thus, there will be no cumulative effects to water beyond those disclosed in the 2015 LTO EIS.

Proposed Action

The projects included in the water supply cumulative impact assessment (discussed above) would generally generate improvements to water supply conditions. This is explained as part of the ROC on LTO. The contribution of the Proposed Action to these conditions would be temporary and limited to September and October of 2019 and not be considered cumulatively substantial.

3.3.2 Biological Resources

No Action Alternative

The No Action Alternative would generate no changes to water operations from the LTO EIS. As such, there would be no change to biological resource conditions in the study area. Continued restoration actions under the No Action Alternative of the 2015 LTO EIS could lead to beneficial biological resource effects, however, the extent would be dependent on project specifics. Thus, there would not be any cumulative effects beyond those disclosed in the 2015 LTO EIS.

Proposed Action

Past, present, and reasonably foreseeable projects, described in the ROC on LTO EIS Appendix Y, *Cumulative Methodology*, may have effects on aquatic resources in the study area that are related to the effects of the Proposed Action described above, including positive and negative effects. The cumulative projects include actions that affect the timing and magnitude of flow releases and seasonal water temperatures and actions that improve habitat of spawning, rearing, and migrating fish in the study area. In reference to Table Y-1 of the ROC on LTO EIS Appendix Y, Reclamation has considered the water supply and water quality projects most likely to have cumulative effects related to the flow and water temperature effects to the Proposed Action area. Those projects most directly linked to the Proposed Action are listed above. Many of these projects (including those not specifically called out in this EA) will not be completed in 2019, thus there will be no effects from those projects. Those projects that are completed or partially completed (for example EcoRestore), will have positive and/or neutral effects to the Proposed Action project area. It is also important to note that each of these projects are and would be subject to environmental regulations and permitting. This, in combination with the temporary nature of the Proposed Action (limited to September and October of 2019), shows the Proposed Action's contribution to adverse cumulative effects would not be substantial.

Section 4 Consultation & Coordination

Several Federal laws, permits, licenses and policy requirements have directed or guided the NEPA analysis and decision-making process included in this EA.

4.1 Public Review Period

This EA is available for public comment and additional analysis will be prepared if substantive comments identify impacts that were not previously analyzed or considered.

4.2 Federal Laws, Regulations, and Policies

Section 7 of the Endangered Species Act (16 USC § 1531 et seq.)

Section 7 of the Endangered Species Act requires Federal agencies to ensure that discretionary federal actions do not jeopardize the continued existence of threatened or endangered species or result in the destruction or adverse modification of the critical habitat of these species. Adverse effects to critical habitat elements may not necessarily rise to the level of adverse modification to critical habitat as a whole.

Magnuson-Stevens Fishery Conservation and Management Act

The Magnuson-Stevens Fishery Conservation and Management Act, as amended by the Sustainable Fisheries Act (Public Law 104 to 297), mandates all federal agencies consult with NMFS on any activities or proposed activities authorized, funded, or conducted by that agency that may adversely impact essential fish habitat (EFH) of commercially managed marine and anadromous fish species (Section 305(b)(2)).

The Delta is designated by NMFS to contain EFH for Chinook salmon, as defined by the Magnuson-Stevens Fisheries Conservation and Management Act of 1994, as amended. EFH refers to those waters and substrates necessary for spawning, breeding, feeding, or growth to maturity. Specific components for EFH in the Delta include juvenile migration corridors and adult migration corridors (PFMC 2003). As described in the LTO EIS, adult Central Valley fall- and late fall-run Chinook salmon use the Delta as a migration pathway from June through December and October through April, respectively (page 9-59). Adult migration in October typically occurs through the Delta for steelhead and fall-run Chinook salmon.

The Proposed Action compared to the No Action Alternative would temporarily affect Delta outflow which could reduce adult migration cues into the Delta and subsequent movement upstream. However, the Proposed Action would not obstruct corridors for adult salmon compared to the No Action. The Proposed Action would not alter Delta habitat and would be limited to temporary changes in Delta outflow.

Fish and Wildlife Coordination Act

The Fish and Wildlife Coordination Act (16 USC 661 et seq.) amended 1946, 1958, 1978, and 1995, was enacted to protect fish and wildlife when Federal actions result in the control or modification of a natural stream or body of water. The statute requires Federal agencies to take

into consideration the effect that water-related projects would have on fish and wildlife resources. Consultation and coordination with the Service and State fish and game agencies are required to address ways to prevent loss of and damage to fish and wildlife resources and to further develop and improve these resources.

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[i] BO, p. 370-371.

[ii] Observed electrical conductivity (EC) data at Belden's Landing so far in 2019 is similar to the previous wet years 2011 and 2017, when salinity was less than 5ppt until the end of August.

[iii] United States Fish and Wildlife Service, Biological Opinion for Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP) ("BO"), 2008, p. 374, Fig, B-17.

[iv] *Brown, L.R., Baxter, R., Castillo, G., Conrad, L., Culberson, S., Erickson, G., Feyrer, F., Fong, S., Gehrts, K., Grimaldo, L., Herbold, B., Kirsch, J., Mueller-Solger, A., Slater, S., Souza, K., and Van Nieuwenhuyse, E., 2014, Synthesis of studies in the fall low-salinity zone of the San Francisco Estuary, September–December 2011: U.S. Geological Survey Scientific Investigations Report 2014–5041, 136 p., http://dx.doi.org/10.3133/sir20145041, p. 83, Table 3-1. [*Table shows only a minor change in low salinity acreage comparing X2 at 81 km and 83km.]

[v] National Research Council (NRC), Committee on Sustainable Water and Environmental Management in the California Bay-Delta, A Scientific Assessment of Alternatives for Reducing Water Management effects on Threatened and Endangered Fishes in California's Bay Delta. 2010, p. 53 ["However, the examination of uncertainty in the derivation of the details of this action lacks rigor. The action is based on a series of linked statistical analyses (e.g., the relationship of presence/absence data to environmental variables, the relationship of environmental variables to habitat, the relationship of habitat to X2, the relationship of X2 to smelt abundance), with each step being uncertain. The relationships are correlative with substantial variance being left unexplained at each step."]

[vi] ICF. 2017. Public Water Agency 2017 Fall X2 Adaptive Management Plan Proposal, submitted to United States Bureau of Reclamation and Department of Water Resources, p. 38, Figure 17 [Approximately 50% of simulations show increase in survival.]

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[xii] Preliminary Draft FLOAT-MAST, p. 50

[xiii] Preliminary Draft FLOAT-MAST, p. 51

[xiv] United States Fish and Wildlife Service, Biological Opinion for Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP), 2008, p. 325.
[xv] Preliminary Draft FLOAT-MAST, p. 42.
[xvi] Preliminary Draft FLOAT-MAST, p 76.
[xvii] United States Fish and Wildlife Service, Biological Opinion for Coordinated Operations of the Central Valley Project (CVP) and State Water Project (SWP), 2008, p. 325.
[xviii] Preliminary Draft FLOAT-MAST, pp. 57-60.
[xix] *Ibid.*