United States Department of the Interior

FISH AND WILDLIFE SERVICE
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In reply refer to:
2022-0059509

Memorandum

To: Manager, Bay Delta Office, U.S. Bureau of Reclamation, Sacramento, California

From: Field Supervisor, San Francisco Bay-Delta Fish and Wildlife Office, U.S. Fish and Wildlife Service, Sacramento, California 11/08/24

Subject: Programmatic Biological Opinion for the Reinitiation of Consultation of the Long-Term Operations of the Central Valley Project and State Water Project

This document transmits the U.S. Fish and Wildlife Service's (Service) programmatic biological opinion (BiOp) on the effects of the Reinitiation of Consultation of the Long-Term Operations of the Central Valley Project and State Water Project (LTO) on federally-listed and proposed species and designated critical habitat. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 *et seq.*) (Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR § 402). In addition, this consultation was coordinated with the public water agencies pursuant to section 4004 of the Water Infrastructure Improvements for the Nation Act (33 U.S.C. 2201 note).

The U.S. Bureau of Reclamation (Reclamation) requested reinitiation of consultation with the Service and the National Marine Fisheries Service (NMFS) on September 30, 2021. In their request, Reclamation stated that the California Department of Water Resources (DWR) would be an applicant for this reinitiation of consultation. On October 1, 2021, the Service and NMFS responded to Reclamation agreeing to reinitiate the consultation. Since that time, the Service, NMFS, Reclamation, the DWR, and the California Department of Fish and Wildlife have collaborated to develop the proposed action for the LTO that is analyzed in this BiOp.

The Service has prepared a mixed programmatic BiOp on LTO, which includes a mix of standard-level and programmatic-level project elements. An analysis and conclusion of whether or not the entire LTO proposed action is likely to jeopardize each listed and proposed species or destroy or adversely modify designated critical habitat is included in this BiOp. The attached BiOp addresses effects of LTO to 16 federally-listed and proposed species and designated critical habitat. The Service has determined that the proposed action may affect, but is not likely to adversely affect four of these species and is not likely to jeopardize the continued existence of 12 species. The Service has determined that the proposed action may affect, but is not likely to adversely affect designated critical habitat for one species and is not likely to destroy or adversely modify designated critical habitat for three species.

If you have any questions on this reinitiation of consultation, please contact me at Donald_Ratcliff@fws.gov or Jana Affonso, Assistant Field Supervisor at Jana_Affonso@fws.gov.

2024 BIOLOGICAL OPINION

REINITIATION OF CONSULTATION ON THE COORDINATED LONG-TERM OPERATION OF THE CENTRAL VALLEY PROJECT AND STATE WATER PROJECT

11/08/24

Donald Ratcliff (Date)

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Table of Contents

Tables

Figures

Acronym List

AF	Acre Feet
AIC	Akaike information criteria
AMA	Adaptive Management Actions
AMP	Adaptive management plan
AMT	Adaptive Management Team
BiOp	Biological Opinion
BRT	Boosted Regression Trees
BSPP	Barker Slough Pumping Plant
CASS	Culture and Supplementation of Smelt
CDFW	California Department of Fish and Wildlife
CEC	Contaminants of emerging concern
CESA	California Endangered Species Act
CFR	Code of Federal Regulations
CMSP	Casswell Memorial State Park
CNDDB	California Natural Diversity Database
CNOR	Candidate Notice of Review
CSC	Cache Slough Complex
CVP	Central Valley Project
DCC	Delta Cross Channel
DCG	Delta Coordination Group
DCP	Delta Conveyance Project
DPS	Distinct population segment
DRY	Drought relief year
DSM2	Delta Simulation Model 2
DWR	Department of Water Resources
ECO	Ecological Particle Tracking (model)
EDSM	Enhanced Delta Smelt Monitoring
EFT	Ecological Flow Tools (SacEFT model)
EIR	Environmental Impact Report
ESA	Endangered Species Act
FAST	Fishery Agency Strategy Team
FAV	Floating Aquatic Vegetation
FCCL	Fish Conservation and Culture Laboratory
FMWT	Fall Midwater Trawl
FNU	Formazine turbidity units
FR	Federal Register
FRP	Fish Restoration Program
FYLF	Foothill Yellow-legged Frog
GGS	Giant Garter Snake

GHG	Greenhouse gas
HGMP	Hatchery and Genetic Management Plan
HRL	Healthy Rivers and Landscapes Program
IEP	Interagency Ecological program
IOP	Interim Operations Plan
IPCC	International Panel on Climate Change
ITP	Incidental Take Permit
ITS	Incidental Take Statement
LBV	Least Bell's Vireo
LCA	Life Cycle Analysis
LCM	Life cycle model
LCME	Life cycle model-entrainment
LCMG	Life cycle model-general
LD50	Lethal dose (50% mortality)
LOE	Lines of Evidence
LTO	Long term operations
MAF	Million Acre Feet
MDR	Maunder and Deriso (model)
MHOS	Milliohms
MIDS	Morrow Island Distribution System
NAA	No Action Alternative
NMFS	National Marine Fisheries Service
NTU	Nephelometric Turbidity Unit
NWR	National Wildlife Refuge
OCAP	Operations Contingency and Plan (2008 Biological Opinion on the SWP and CVP operations)
OMR	Old and Middle River (flow)
OMRI	Old and Middle River Index
PA	Proposed Action
PBF	Physical and biological features
PCE	Primary constituent element
PCFFA	Pacific Coast Federation of Fishermen's Associations
PSU	Practical Salinity Units
PTM	Particle Tracking Model
ROD	Record of Decision
RRDS	Roaring River Distribution System
SAV	Submerged aquatic vegetation
SCHISM	Semi-implicit Cross-scale Hydroscience Integrated System (Model)

SFBBO	San Francisco Bay Bird Observatory
SHOT	Shasta Operation Team
SJRNWR	San Joaquin River National Wildlife Refuge
SKT	Spring Kodiak Trawl
SLS	Smelt Larval Survey
SMSCG	Suisun Marsh Salinity Control Gates
SMT	Science Management Team
SNPL	Snowy plover
SR	State route
SRSC	Sacramento River Settlement Contractors
SSA	Species Status Assessment
SSM	State-space model
SWP	State Water Project
SWRCB	State Water Resources Control Board
TAF	Thousand Acre Feet
TUCO	Temporary Urgency Change Order
TUCP	Temporary Urgency Change Petitions
USFWS	United States Fish and Wildlife Service
USGS	United States Geological Survey
VA	Voluntary Agreements
VELB	Valley Elderberry Longhorn Beatle
WIIN	Water Infrastructure Improvements for the Nation Act
WOMT	Water Operations Management Team
WQCP	Water Quality Control Plan
WY	Water Year
WYBC	Western Yellow-Billed Cuckoo
X2	Location of 2 parts per thousand salinity
XGEO	Cross-delta flow
YBWA	Yolo Bypass Wildlife Area

1. Introduction

This Biological Opinion and Conference Opinion (BiOp) is in response to the Bureau of Reclamation (Reclamation) and the California Department of Water Resources (DWR) September 30, 2021 request for reinitiation of formal consultation with the U.S. Fish and Wildlife Service (Service) on the proposed Coordinated Long-Term Operation (LTO) of the Central Valley Project (CVP) and State Water Project (SWP) (proposed action [PA]). The request was received by the Service on September 30, 2021. The Service agreed with the request by letter dated October 1, 2021.

This BiOp addresses the PA's effects on federally-listed species and designated critical habitat. This response is provided under the authority of the Endangered Species Act of 1973, as amended (16 U.S.C. 1531 et seq.) (ESA, or Act), and in accordance with the implementing regulations pertaining to interagency cooperation (50 CFR 402). Pursuant to 50 CFR 402.12(j), Reclamation submitted a Biological Assessment (BA) for our review and requested concurrence with the findings presented therein. These findings are listed in Table 1-1.

Table 1-1: Species and Critical Habitat Determinations

Species	Reclamation Determination	Changes to Final Determination
California Least Tern (*Sterna antillarum browni*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
California Ridgway's Rail (*Rallus obsoletus obsoletus*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Delta Smelt (*Hypomesus transpacificus*)	May Affect- Likely to Adversely Affect	No Change
Delta Smelt Critical Habitat	May Affect- Likely to Adversely Affect	No Change
Foothill Yellow-legged Frog Southern Sierra Distinct Population Segment (*Rana boylii*)	May Affect- Not likely to Adversely Affect	No Change
Least Bell's Vireo (*Vireo bellii pusillus*)	May Affect- Not likely to Adversely Affect	No Change
Giant Garter Snake	May Affect- Not Likely to	May Affect – Likely to

Species	Reclamation Determination	Changes to Final Determination
(*Thamnophis gigas*)	Adversely Affect	Adversely Affect
San Francisco Bay-Delta Distinct Population Segment of the Longfin Smelt (*Spirinchus thaleichthys*)	May Affect- Likely to Adversely Affect	No Change
Northwestern Pond Turtle (*Actinemys marmorata*)	May Affect- Likely to Adversely Affect	No Change
Riparian Brush Rabbit (*Sylvilagus bachmani riparius*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Riparian Woodrat (*Neotoma fuscipes riparia*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Salt Marsh Harvest Mouse (*Reithrodontomys raviventris*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Soft Bird's-Beak (*Cordylanthus mollis ssp. Mollis*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Soft Bird's-Beak Critical Habitat	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Suisun Thistle (*Cirsium hydrophilum var. hydrophilum*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Suisun Thistle Critical Habitat	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Valley Elderberry Longhorn Beetle (*Desmocerus californicus dimorphus*)	May Affect- Not likely to Adversely Affect	No Change
Valley Elderberry Longhorn Beetle Critical Habitat	May Affect- Not likely to Adversely Affect	No Change
Western Snowy Plover (*Charadrius nivosus nivosus*)	May Affect- Not likely to Adversely Affect	May Affect- Likely to Adversely Affect
Western Yellow-billed Cuckoo (*Coccyzus americanus*)	May Affect- Not likely to Adversely Affect	No Change
Western Yellow-billed Cuckoo Critical Habitat	May Affect- Not likely to Adversely Affect	No Change

See the attached Effects Tracking Table (Appendix 1) for the species and critical habitat that may be affected by all of the elements of the Proposed Action (PA).

Not Likely to Adversely Affect

The Service concurs with Reclamation's determination that the PA may affect but is not likely to adversely affect the species listed below and referenced in Table 1-1. Unless new information reveals effects of the PA that may affect listed or proposed species in a manner or to an extent not considered, or a new species is listed or critical habitat is designated that may be affected by the PA, no further action pursuant to the Act is necessary.

Foothill Yellow-legged Frog South Sierra Distinct Population Segment

After reviewing all available information, the Service concurs with Reclamation's determination that the proposed action may affect but is not likely to adversely affect the foothill yellow-legged frog (FYLF) due to the following reasons: (1) the environment within the Action Area is either unsuitable (impounded water) or low quality (highly incised channel, little direct sunlight, scarcity of shallow-water breeding habitat, highly variable flows), (2) only a small portion of the South Sierra Distinct Population Segment (DPS) that occurs within the Action Area contains potentially suitable habitat (Stanislaus River from Goodwin dam to approximately 2 ½ miles downstream), (3) the closest known population of FYLF is more than 15 miles away on Coyote Creek (a tributary to New Melones reservoir) and further separated by Goodwin and New Melones dams and their associated impounded waters, (4) FYLF habitat quality within this portion of the Stanislaus River likely has been degraded and/or unsuitable from as long ago as the 1910s (Goodwin dam) and the 1970s (New Melones dam) due to the highly variable (unnatural) flow releases from these dams over the decades of their operations, and (5) bullfrogs, crayfish, and various trout species (all known predators of FYLF) are known to occur within the Action Area.

Least Bell's Vireo

Seasonal Operations

The least Bell's vireo (LBV) has been documented to occur within the Action Area primarily around the San Joaquin and Stanislaus River watersheds although occurrences are rare and the Action Area is considered at the edge of its current distribution. To date, there was a single documented occurrence within the Yolo Bypass Wildlife Area, but the only confirmed successful nesting near the Action Area was on the San Joaquin River National Wildlife Refuge (SJRNWR) in Stanislaus County. In restored riparian habitat in the SJRNWR, there were successful nesting events by a pair of vireos in 2005 and 2006, along with an unsuccessful nesting attempt in 2007 (Howell *et al.* 2010). It appears that these nests were not within the levees of the San Joaquin River; therefore, they were outside of the Action Area. The LBV is an obligate riparian species during the breeding season and is characterized as preferring early successional habitat. This species typically inhabits structurally diverse woodlands along watercourses, including cottonwood-willow forests, oak woodlands, and mule-fat scrub. The primary threat to the LBV in the Action Area is the loss of this riparian habitat due to dams and the alteration of downstream channels by surface and groundwater diversions, levees and flood control/bank stabilization structures, agriculture (including ranching), and other land conversions.

The Service acknowledges that the Action Area is lacking in the hydrographic components required for the natural conditions needed for riparian vegetation growth, establishment, and succession as a result of operation of water storage and conveyance facilities in the San Joaquin and Stanislaus River watersheds. These are major factors in the reduction of suitable LBV habitat and are likely to continue without changes to water release strategies, management, or restoration efforts. However, these conditions have been in place since the time when the first phases of the CVP and SWP were implemented from the completion and operation of the Friant Dam on the San Joaquin River in the 1940's, to the completion and operations of the New Melones Dam on the Stanislaus River since the 1980's, to the coordinated operation of the CVP and SWP in 1986, and are considered as part of the Environmental Baseline.

The PA includes proposed flow changes in the Stanislaus River and seasonal operations under the PA that may reduce natural variability beyond major flood events. Seasonal operations will likely contribute to the further reduction of natural successional processes that result in non-climax stage riparian woodlands and loss of suitable LBV habitat over time; however, it is assumed that seasonal operations under the PA will on average maintain current vegetation. It is expected that implementation of the PA will result in similar habitat conditions currently being experienced by the LBV. In considering the baseline conditions that have occurred in the Action Area for nearly four decades or more and that occurrences and breeding of the LBV in the Action Area are rare, the Service has not identified any measurable effects that would arise from the proposed seasonal operations in the PA.

Spring Pulse Flows

The spring pulse flows in the PA may benefit LBV by supporting the recruitment of important early successional habitat. The BA did not include ecological flow modeling (such as SacEFT) that would support a quantitative assessment of how much these flows will actually benefit riparian plant communities and sustain LBV habitat. We assume that the proposed spring pulse flows could benefit the LBV to an unknown amount. Therefore, the Service concurs with Reclamation's determination the PA is not likely to adversely affect the LBV.

Critical habitat has been designated for the LBV, but it does not occur in the Action Area.

Valley Elderberry Longhorn Beetle

The valley elderberry longhorn beetle (VELB) is solely associated with the elderberry shrub, primarily the blue elderberry shrub (*Sambucus nigra* subsp. *caerulea*, formerly *S. mexicana*), for its habitat as these plants are an obligate host plant for larvae and are necessary for the completion of their life cycle. Elderberry shrubs are commonly found in riparian habitats along the banks of rivers and streams. They are most common on higher and older riparian terraces where the roots of the plant are able to reach the water table and where the plants are not inundated for long periods. The PA includes proposed flow changes in the Sacramento River, the American River and the Stanislaus River. VELB is known to occupy riparian habitats in these watersheds with their host plant. Periodic flooding and erosion are important to maintaining successional riparian ecosystems and seasonal operations under the PA may reduce natural variability beyond major flood events. However, seasonal operations of the Sacramento, American, and Stanislaus watersheds are not likely to diminish the amount or density of elderberry shrub habitat for the VELB as these plants are not reliant on periodic flooding or increases in river flow and would not likely be adversely affected by the maintenance of river flows. Reclamation is also not proposing the *Salmonid Spawning and Rearing Habitat Restoration* as it proposed in the 2019 PA that had potential adverse effects from construction. Experimental food enhancement actions in the Yolo Bypass under adaptative management are unlikely to result in adverse effects as there are no known occurrences in the area. The Service does not anticipate the density or amount of elderberry shrubs in the Action Area would likely be diminished due to the PA and therefore the VELB is also not likely to encounter a reduction in numbers or fitness from a loss of habitat due to the PA. Therefore, the Service concurs with Reclamation's determination that the PA is not likely to adversely affect the VELB.

Western Yellow-billed Cuckoo

Seasonal Operations

The western yellow-billed cuckoo (WYBC) and a portion of its critical habitat occur within the Action Area. The WYBC is primarily dependent on riparian habitat for its survival in the Action Area and it utilizes the Sacramento, American, and the Stanislaus watershed riparian habitats for feeding, breeding (nesting), and sheltering during its migration seasonally from Central and South America into Northern California and back. Most detections have occurred in the upper Sacramento River compared to the other major rivers in the Action Area. The primary threats to the WYBC are the loss of contiguous riparian habitat due to dams and the alteration of downstream channels by surface and groundwater diversion; encroachment of levees and flood control and bank stabilization structures into the river channel and floodplain; transportation systems; gravel mining; agriculture including ranching; and conversion to non-native invasive plant communities (79 FR 48547). The Service acknowledges that the Sacramento River is lacking in the hydrographic components that reduce channel dynamics which cause the diminishment or loss of the natural conditions needed for riparian vegetation growth, establishment, and succession as a result of operation of water storage and conveyance facilities in the Sacramento River watershed. These are major factors in the reduction of suitable cuckoo habitat and are likely to continue without changes to water release strategies, management, or restoration efforts. However, these conditions have been in place since the time when the first phases of the CVP and SWP were implemented, from the completion and operation of the Shasta Dam in the 1940's to the cooperative operation of the CVP and SWP in 1986, and are considered as part of the Environmental Baseline. The PA includes proposed flow changes in the Sacramento River and seasonal operations under the PA that may reduce natural variability beyond major flood events. Seasonal operations will likely contribute to the further reduction of natural successional processes that result in non-climax stage riparian woodlands and loss of suitable WYBC habitat over time; however, it is assumed that seasonal operations under the PA will on average maintain current vegetation. It is expected that implementation of the PA will result in similar habitat conditions currently being experienced by the WYBC. In considering the baseline conditions that have occurred in the Action Area for nearly four decades or more, the Service has not identified any measurable effects that would arise from the proposed seasonal operations in the PA.

Spring Pulse Flows

The spring pulse flows in the PA may benefit WYBC by supporting the recruitment of important riparian tree species, primarily willows. The PA does not describe the incorporation of flow recession during the germination and seedling establishment for riparian over-story species (particularly Fremont cottonwood). Additionally, the BA did not include ecological flow modeling (such as SacEFT) that would support a quantitative assessment of how much these flows will actually benefit riparian plant communities and sustain WYBC habitat. We assume that the proposed spring pulse flows could benefit the WYBC to an unknown amount from now until about 2037 (the quantitative extent of the analysis in this BiOp based on the modeling provided).

Reclamation is also no longer proposing the Salmonid Spawning and Rearing Habitat Restoration that had potential adverse effects from construction; therefore, the Service concurs with Reclamation's determination the PA is not likely to adversely affect the WYBC.

Western Yellow-billed Cuckoo Critical Habitat

In addressing the WYBC's critical habitat unit 63: CA -1 Sacramento River, Colusa, Glenn, Butte, and Tehama Counties, California, which occurs in the Action Area, the Service has identified three physical and biological features (PBF) of the critical habitat essential to the conservation of the WYBC.

PBF 1. Range wide breeding habitat – Riparian woodlands across the range of the DPS. Drainages with varying combinations of riparian, xeroriparian, and/or non-riparian trees and large shrubs. This PBF includes breeding habitat found throughout the DPS range as well as additional breeding habitat characteristics unique to the Southwest. This factor is unlikely to be significantly altered in the critical habitat unit as the baseline conditions of this PBF are effectively unchanged by the seasonal operations under the PA on the Sacramento River.

PBF 2. Adequate prey base – Presence of prey base consisting of large insect fauna (for example, cicadas, caterpillars, katydids, grasshoppers, large beetles, dragonflies, moth larvae, spiders), lizards, and frogs for adults and young in breeding areas during the nesting season and in post breeding dispersal areas. This factor is primarily driven by surrounding habitat uses and application of insecticides. The PA is not expected to have adverse effects or contribute to the loss of prey base beyond current baseline conditions.

PBF 3. Hydrological processes – The movement of water and sediment in natural or altered systems that maintains and regenerates breeding habitat. This PBF includes hydrologic processes found in range wide breeding habitat as well as additional hydrologic processes unique to the Southwest in southwestern breeding habitat. This factor is unlikely to be significantly altered in the critical habitat unit as the baseline conditions of this PBF are effectively unchanged by the seasonal operations under the PA on the Sacramento River.

The Service concurs with Reclamation's determination that the PA is not likely to adversely affect this critical habitat unit based on the rationale and baseline conditions described above.

Consultation History

Reclamation has consulted with the Service on CVP and SWP operations as species were listed and critical habitat designated since the early 1990s. The most recent consultation on CVP and SWP long-term operations was completed in 2019, with a February 2020 Record of Decision (ROD) from Reclamation. The 2019 Biological Opinion was challenged in federal court with litigation stayed pending voluntary remand. The following includes key points in the history of consultations on CVP and SWP long-term operations prior to the 2019 Biological Opinion; the remainder of the pre-2019 Consultation History is incorporated by reference from the 2019 Biological Opinion.

- 1992: Reclamation provided an Interim Central Valley Project Operations Criteria and Plan (OCAP).

- 1995: The Service issued a Biological Opinion for delta smelt with a finding of non-jeopardy and reasonable and prudent measures to minimize the impact of incidental take.

- 2004: The Service issued a Biological Opinion for delta smelt with a finding of non-jeopardy and reasonable and prudent measures to minimize incidental take.

- 2005: The Department of the Interior was sued on the Service's 2004 Biological Opinion and Reclamation reinitiated consultation with the Service and the National Marine Fisheries Service (Service).

- 2005: The Service issued its Reinitiation of Formal and Early Section 7 Endangered Species Consultation on the Coordinated Operations of the Central Valley Project and State Water Project and the Operations Criteria and Plan to address potential critical habitat issues.

- 2006: Reclamation requested reinitiation of consultation on CVP/SWP operations based on new species listings and designated critical habitats.

- 2006: Reclamation requested informal consultation on coordinated operations of the CVP and SWP and their effects on delta smelt.

- 2007: As a result of the litigation, the 2005 Biological Opinion was invalidated and the Service was ordered to develop a new Biological Opinion by September 15, 2008.

- 2008: Reclamation provided a Biological Assessment citing the pelagic organism decline and listing of green sturgeon as the reasoning for reinitiation of consultation and with a determination of likely to adversely affect delta smelt and delta smelt critical habitat.

- 2008: The Service issued a Biological Opinion which found the action was likely to jeopardize delta smelt and destroy or adversely modify designated delta smelt critical habitat. This Biological Opinion included a Reasonable and Prudent Alternative to avoid jeopardy and adverse modification.

- 2016: Reclamation, with DWR as the Applicant, jointly requested reinitiation of ESA Section 7 consultation with the Service and NMFS on the Coordinated Long-Term Operation of the CVP and SWP based on new information related to multiple years of drought, recent data demonstrating low delta smelt populations and extremely low listed-salmonid population levels for the endangered winter-run Chinook salmon, and new information available and expected to become available as a result of ongoing work through collaborative science processes.

- 2019: Reclamation provided a Biological Assessment to support the 2016 request for reinitiation of consultation.

- 2019: On October 21, the Service issued a Biological Opinion for delta smelt, delta smelt critical habitat, and several terrestrial species. The Service determined that the action was not likely to jeopardize any of the subject species, and not likely to destroy or adversely modify any designated critical habitat.

The following is the Consultation History after the 2019 Biological Opinion was issued. The following is not an exhaustive account of the numerous meetings to discuss the PA and effects to listed species and critical habitat, which occurred at least weekly if not more frequently since 2021.

- December 2, 2019: Pacific Coast Federation of Fishermen's Associations, Institute for Fisheries Resources, Golden State Salmon Association, Natural Resources Defense Council, Inc., Defenders of Wildlife, and the Bay Institute (collectively, the PCFFA Plaintiffs) filed a complaint for declaratory and injunctive relief with the Northern District of California. In the complaint, Plaintiffs challenged the validity of the Service's and NMFS's October 21, 2019 Biological Opinions.

- February 19, 2020: Reclamation issued a Record of Decision (ROD) on CVP operations.

- February 20, 2020: The State of California (State Plaintiffs) filed a complaint for declaratory and injunctive relief with the Northern District of California against the Service, NMFS, and Reclamation on the 2019 Biological Opinions and 2020 ROD.

- February 24, 2020: PCFFA Plaintiffs filed an amended complaint for declaratory and injunctive relief adding a challenge to the 2020 ROD. The PCFFA and State cases were subsequently transferred to the Eastern District of California (the Court).

- March 13, 2020: Reclamation sent a letter to the Service describing additional Old and Middle River flow restrictions for the protection of larval and juvenile delta smelt developed from the Service's recently completed Delta Smelt Life Cycle Model as provided for in the 2019 BiOp.

- May 14, 2020: The Service emailed Reclamation and DWR stating that the Condition of Approval 8.12 from the California Department of Fish and Wildlife (CDFW) 2020 Incidental Take Permit was sufficient to satisfy the requirement in our 2019 Biological Opinion for protection of larval delta smelt from Barker Slough Pumping Plant operations.

- May 11, 2020: The Court issued an order enjoining Reclamation from operating inconsistent with the I:E ratio as described in NMFS's 2009 Reasonable and Prudent Alternative.

- October 21, 2020: The Service completed the Delta Smelt Supplementation Strategy and transmitted it to Reclamation and other partners.

- October 23, 2020: Pursuant to Reasonable and Prudent Measure 1 of the 2019 Biological Opinion, Reclamation provided the Standard Operating Procedures for their Tracy Fish Collection Facility.

- October 30, 2020: The Service approved Reclamation's request for modification of Clifton Court Forebay Aquatic Weed and Algal Bloom Management Activities.

- December 15, 2020: Reclamation noticed the Service, NMFS, and DWR of their determination that the Predatory Fish Removal and Relocation Study in the Clifton Court Forebay would not result in effects beyond what was analyzed in the 2019 Biological Opinions.

- May 30, 2021: The Service and NMFS sent a joint letter to Reclamation regarding Reclamation's Temporary Urgency Change Petition filed with the State Water Resources Control Board (SWRCB) outlining technical assistance provided on biological considerations.

- September 30, 2021: Reclamation requested reinitiation of consultation on the long-term operations of the CVP and SWP of the Service and NMFS.

- October 1, 2021: The Service and NMFS sent letters agreeing to Reclamation's request to reinitiate the consultation.

- March 10, 2022: Reclamation and DWR started a facilitated process of small groups tasked with developing each element of the PA and incorporating input from CDFW, NMFS, and the Service. A team made up of decisionmaker-level representatives from each agency met weekly to discuss and resolve proposed action and consultation matters.

- March 11, 2022: The Court granted the government's motions for voluntary remand without vacatur of the 2019 Biological Opinions, imposing an Interim Operations Plan through the end of Water Year (WY) 2022, and staying the cases challenging the 2019 Biological Opinions.

- March 25, 2022: The Service sent a letter to the SWRCB regarding Reclamation and DWR's Temporary Urgency Change Petition request, which outlined technical assistance provided to Reclamation and DWR on their request.

- October 7, 2022: The Service published a proposed rule in the Federal Register to list the Bay-Delta DPS of longfin smelt as endangered.

- October 19, 2022: The Service sent a letter approving Reclamation's request for modification of Clifton Court Forebay Aquatic Weed and Algal Bloom Management Activities.

- February 24, 2023: The Court issued an order granting an extension of the WY2022 IOP and staying the cases through December 31, 2023.

- June 30, 2023: Reclamation provided a qualitative draft Biological Assessment with the structure of Reclamation's analysis, information to support an Environmental Baseline, identification of the stressors that may affect species, and the information that would be developed for a quantitative document.

- November 10, 2023: Reclamation transmitted to the Service the Biological Assessment for delta smelt, delta smelt critical habitat, and the San Francisco Bay-Delta DPS of the longfin smelt (longfin smelt DPS), and requested formal conference on the longfin smelt DPS. In the email, Reclamation stated that some modeling and supporting analyses were ongoing and included a list of the forthcoming analyses.

- November 18, 2023: Reclamation transmitted the remainder of the Biological Assessment for California clapper rail, California least tern, least bell's vireo, salt marsh harvest mouse, Suisun thistle, soft bird's-beak, valley elderberry longhorn beetle, riparian brush rabbit, riparian woodrat, Southern Sierra DPS of foothill yellow-legged frog, western yellow-billed cuckoo, and the western snowy plover, and critical habitat for Suisun thistle, soft bird's-beak, valley elderberry longhorn beetle, and western yellow-billed cuckoo to the Service.

- November 28, 2023: Reclamation provided a link to access Appendix F (Modeling) of the BA.

- December 6, 2023: Reclamation transmitted the following documents that are part of the BA: Adaptive management plan and associated appendices, Tracy Fish Collection Facility Standard Operating Procedures, Skinner Fish Facility Operations Manual, Barker Slough, Clifton Court Forebay Weed Management, Drought Toolkit.

- December 11, 2023: Reclamation transmitted technical assistance responses to the Service and NMFS from the BA guided tours.

- December 18, 2023: Reclamation transmitted the following documents that are part of the BA: Flow Threshold Salmon Survival and Tidal Habitat Restoration appendices.

- December 20, 2023: The Service requested additional information from Reclamation based on the initial review of the BA, including a spreadsheet with categorized comments and questions. The email also addressed non-concurrences for some species, and some global comments.

- December 29, 2023: The Court issued an order continuing the stay of the cases and continuing the WY2023 IOP provisions through March 31, 2024.

- January 5, 2024: Reclamation transmitted the following documents that are part of the BA: Appendix F - Modeling Lines of Evidence, Appendix N - Stanislaus Stepped Release Plan LOE, and Appendix P - Delta Habitat.

- January 5, 2024: Reclamation transmitted the OMR ECO PTM LOE appendix to the BA.
- January 10, 2024: Reclamation transmitted the BA sufficiency review documents to interested parties.
- February 5, 2024: The Service met with Reclamation, NMFS, and ICF to discuss the December 20, 2023 comments.
- February 6, 2024: Reclamation transmitted the following documents that are part of the BA: Appendix H – Conservation Measures Deconstruction and Appendix I – Particle Tracking, Fate Modeling, Larval Entrainment.
- February 7, 2024: Reclamation transmitted the OMR Flow into Junction Analysis section of the BA.
- February 12, 2024: The Service met with Reclamation and ICF to continue discussion on the December 20, 2023 comments.
- February 23, 2024: The Service met with Reclamation and ICF to continue discussion on the December 20, 2023 comments.
- February 29, 2024: Reclamation transmitted the LCA OBAN appendix to the BA.
- March 8, 2024: Reclamation transmitted the Inland and Coastal Action Area map and LCA Food Availability Analysis for Southern Resident Killer Whale appendix to the BA.
- March 13, 2024: Reclamation transmitted the TUCP Sensitivity Analysis Trend Report appendix of the BA.
- March 20, 2023: Reclamation transmitted the SCHISM appendix of the BA.

- March 28, 2024: The Court issued an Order extending in part and denying in part the WY2024 IOP.

- April 2, 2024: The Court issued an order entering the WY2024 IOP, as modified by the Court's March 28, 2024 order, and staying the cases until Reclamation issues a new ROD or until December 20, 2024, whichever occurs first.

- June 28, 2024: The Service transmitted portions of the draft BiOp to parties identified in the Water Infrastructure Improvements for the Nation (WIIN) Act and other interested parties. Comments were requested by July 15, 2024.

- June 28, 2024: The Service provided the draft BiOp to a selected team of peer reviewers for their independent scientific review. Comments were requested by July 29, 2024.

- July 11, 2024: The Service granted a two-week extension to the WIIN parties and other interested parties until July 29, 2024 for review of the draft BiOp.

- July 29, 2024: The Service received 11 response letters from WIIN parties and other interested parties on the draft BiOp. The Service also received comments from the independent scientific peer reviewers.

- July 30, 2024: The Service published in the Federal Register a final rule listing the longfin smelt DPS as endangered. The final listing became effective on August 29, 2024.

- September 3, 2024: Reclamation transmitted an updated version of the PA. This transmittal did not include any updates to the appendices to the PA, including the adaptive management plan.

- September 6, 2024: Reclamation transmitted a revised effect determination for foothill yellow-legged frog. The determination was changed from “may affect, likely to adversely affect” to “may affect, not likely to adversely affect”.

- September 11, 2024: Reclamation transmitted the proposed conservation measures for northwestern pond turtle to the Service.

- September 24, 2024: Reclamation transmitted to the Service, NMFS, CDFW, and DWR an updated version of the PA showing the changes from November 2023 to current.

- September 26, 2024: The draft incidental take statement for delta smelt and longfin smelt DPS were provided to interested parties for their review and input.

- October 23, 2024: Reclamation transmitted to the Service, NMFS, CDFW and DWR the final version of the PA.

Consultation Approach

ESA regulations require that all effects of the action including “all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action but that are not part of the action” (50 CFR 402.02) are addressed in consultation. For the components of the PA that cause consequences that would not occur “but for” the PA and are reasonably certain to occur, this consultation analyzes consequences from these “other activities”. Not all of these other activities are specifically proposed by Reclamation or are actions over which Reclamation has claimed they have discretionary authority, but pursuant to 50 CFR 402.02, effects of these other activities are addressed in this consultation.

The purpose of this section 7 consultation is to evaluate the effects of the PA on listed and proposed species and designated critical habitat. After reviewing the action as proposed by Reclamation, the Service has determined that the PA presents a mixed programmatic action, as defined in 50 CFR 402.02. The Service's consultation includes a mix of standard consultation and stand-alone programmatic (both of which include an Incidental Take Statement [ITS]) and framework programmatic consultation (for which an ITS is not required at the programmatic stage). An analysis and conclusion of whether or not the entire PA is likely to jeopardize the continued existence of listed and proposed species or result in the destruction or adverse modification of their critical habitat is included in this BiOp.

Some of the PA elements are described at a site-specific level with no future federal action required, unless reinitiation of consultation is necessary pursuant to 50 CFR 402.16 (standard). For the remainder of the elements, the PA describes activities in new or on-going programs, some of which can tier to this BiOp or other existing programmatic consultations (stand-alone programmatic), and some activities which will require subsequent consultations prior to implementation (framework programmatic). This BiOp uses a combination of a framework and stand-alone programmatic approach to discuss the process for future project-specific (for framework) or tiered (for stand-alone) consultations. This BiOp contains an ITS for those consultation elements for which incidental take is reasonably certain to occur for an individual species that are addressed under a standard, site-specific level or under a stand-alone programmatic approach.

This consultation includes a mix of ongoing and newly proposed activities. There are some activities that were previously proposed in the 2019 consultation that are no longer proposed in this consultation (see *Activities proposed in the 2019 consultation that are no longer proposed under LTO* section below). In addition, there are ongoing activities having independent utility that may have undergone separate Section 7 consultations, which are not being reinitiated in this consultation but warrant consideration for the jeopardy and adverse modification analysis for their effects to listed species and designated critical habitat. These activities are part of the Environmental Baseline insofar as those separate consultations remain effective for the entirety of those actions. If a separate consultation becomes no longer effective (the proposed timeframe ends, reinitiation of consultation is triggered, etc.) and the action is ongoing or is not yet complete, a new or reinitiated consultation must be completed to provide section 7 compliance; those actions are not analyzed in this BiOp.

See the attached Effects Tracking Table for an accounting of how elements of the PA are binned by consultation type.

Standard Consultation

For standard consultation activities, there is enough information available in the BA or elsewhere to address the specific effects without the need for subsequent or tiered consultations in the future. These activities do not require future federal approvals and could be implemented at any point after the federal action occurs. Quantitative modeling and analyses that support the effects analysis and an ITS are available and utilized where appropriate.

Stand-alone Programmatic Consultation

Stand-alone programmatic consultation is designed to be used for a specific program of actions or series of related actions. In this BiOp, there is enough information to support an ITS for these programs; therefore, incidental take is quantified and an ITS is included pursuant to ESA Section 7(b)(4). The following information will be provided by Reclamation and/or DWR for specific actions under these programs prior to implementation in order to evaluate whether or not they can be tiered to this stand-alone programmatic consultation:

- Individual project description
- Individual project environmental baseline
- Confirm project components were described/evaluated at the program level
- Confirm specific effects were evaluated at the program level

- Confirm project specific action area is within the programmatic action area

- Confirm no new information on the species/critical habitat would modify the effects in the stand-alone programmatic consultation

- Confirm project-specific effects were evaluated in this BiOp

- Confirm the section 7(a)(2) conclusion in this BiOp has not changed for the species affected in the specific action

Framework Programmatic Consultation

For framework programmatic actions, an ITS is not required at the program (framework) level for those actions falling within the definition of framework programmatic action (50 CFR 402.02). Framework programmatic portions of the PA will require separate, project-specific section 7 consultations as part of the subsequent approval. Framework programmatic actions establish a framework for the development of future actions that are authorized, funded, or carried out at a later time, and any take of a listed species would not occur unless and until those future actions are authorized, funded or carried out and subject to further section 7 consultation. This BiOp provides a framework for future, site-specific actions that are subject to section 7 consultations and ITSs. Subsequent consultations associated with these programmatic actions will develop the necessary site-specific information to inform an assessment of where, when, and how listed species and critical habitat are likely to be affected.

Future components of the PA will be developed and implemented in a manner that is consistent with on-going planning efforts and the framework in this BiOp.

Activities proposed in the 2019 consultation that are no longer proposed under LTO

There are several components of the PA in the 2019 consultation that are no longer included in the 2024 PA. The following list includes components that were addressed at a site-specific, standard level and some that were addressed programmatically because they were part of larger programs that had existing programmatic consultations or previously analyzed activities within these programs that had stand-alone consultations.

- Operations with a Raised Shasta Dam
- Battle Creek Salmon and Steelhead Restoration Project and Battle Creek Reintroduction Plan
- Spawning and Rearing Habitat Restoration on the Tributaries
- Lower San Joaquin River Habitat
- Yellow-Billed Cuckoo Surveys
- Sacramento Deepwater Ship Channel Food Study
- Delta Cross Channel Improvements
- Sediment Supplementation
- Predator Hotspot Removal
- Installation of Agricultural Barriers (note: operations with agricultural barriers is addressed in this BiOp)
- Clifton Court Forebay Predator Management
- Suisun Marsh/Roaring River Distribution System Food Study

Because these activities are no longer proposed under LTO, effects of these activities are not analyzed in this BiOp. Any past effects of these activities are considered as part of the Environmental Baseline.

New activities proposed that were not proposed in the 2019 consultation

The following newly proposed PA elements were not included in the 2019 consultation:

- Future Operations of the proposed Sites Reservoir and Delta Conveyance projects
- Adaptive Management Program
- Shasta Framework
- Winter-Run Action Plan
- Shasta Operations Team
- Programmatic approach for monitoring
- Spring Delta Outflow/Healthy River and Landscapes Program
- Longfin smelt Old and Middle River (OMR) measures
- Updates for Delta Smelt Supplementation

The species and critical habitat affected and the consultation approach for these and all proposed elements are described in the attached Effects Tracking Table.

Description of Modeling Tools

The analysis provided by Reclamation is supported by CalSim 3 and DSM2 modeling. CalSim 3 is a monthly time-step model that predicts the responses of the CVP and SWP systems to climatic inputs and user-defined operating rules over a 100-year adjusted historical hydrology (1922-2021), which includes multiple examples of all water year types. It is considered by Reclamation to be the best available planning-level analytical tool for evaluating alternative CVP and SWP operations (*BA Appendix F – Modeling, Section 3.2*). Most operational actions included in the PA that are intended to provide protections for species will occur on a time-step shorter than the model's one-month intervals. Because of this, assumptions are made to try to best reflect how Reclamation expects short-term actions will play out on a monthly time scale. The monthly averages output by CalSim 3 may not capture the conditions that species experience in the Delta at any given time. Thus, the CalSim 3 operating assumptions and results are not fully reflective of conditions in the

Delta in any given time period but are suitable for our comparative analysis of expected differences among scenarios.

DSM2 is a hydrodynamic and water quality model used to simulate flows and water quality in the Delta. DSM2 can be run at time-steps as short as 15 minutes and can run using 'down-scaled' results from CalSim 3 as input boundary conditions. The down-scaled inputs are probabilistic and as such are statistical approximations of daily time scale variability in river inputs. In addition, DSM2 has a particle tracking module that was used to illustrate how water and by extension, planktonic organisms may be moved around the Delta by tidal (dispersive) and net (advective) flows.

Used together, CalSim 3 and DSM2 are useful for understanding how variation in the weather interacts with different operational rules to affect river flows and hydrodynamic conditions as those flows mix into the Delta and are then moved seaward or into water diversions. Changes resulting from implementation of the PA may influence habitat conditions for delta smelt and the longfin smelt DPS, predominantly by affecting Delta outflow, which in turn affects the location and details of the ecological function of the low-salinity zone (Mac Williams *et al*. 2015, entire). These linkages are covered in more detail in the appropriate species effects sections of this BiOp.

Life Cycle Models: There are a number of statistical models available that can be used to generate some form of life cycle analysis for delta smelt and the longfin smelt DPS. These tools are better developed for delta smelt given its longer research emphasis. For delta smelt, we focus mainly on variations of statistical models that Reclamation included in their BA (*Appendix F, Attachments F and X*). Both attachments to *Appendix F* are incorporated here by reference to describe the methods used and important modeling caveats as fully as possible. Briefly, both *Appendix F* attachments describe how delta smelt life cycle modeling tools were adapted to use CalSim 3 outputs to support the BA for model years 1995-2015. We revisit these models in different parts of our effects analysis to which they are relevant. The delta smelt models are all 'state-space models' fit to historical catch data. State-space models fit two linked models at the same time. One is a 'process model' that is a statistical description of what is happening in the delta smelt's life cycle within and across generations; specifically, production of each new generation and its subsequent survival to adulthood repeated over time. The process model sets a few important 'ground rules' that inform the 'observation model' described below. In the specific case of the delta smelt models, the process model says the fish live one year, then spawn and die. It also limits abundance to the same number or fewer than the prior life stage due to mortality and abundance can only increase following reproduction.

The process model is linked to an observation model. The observation model takes in the catch data and determines the 'observation error' or the variability of the catch, which is distinct from the 'process error' or variability associated with the population. 'Observation error' helps the state-space model separate variation due to imperfect sampling from variation caused by something else – either randomness or some hypothesized causal factor in the fish's environment. Hereafter, the acronym SSM will be used as shorthand for state-space model.

The SSMs quantify the correlation between predictor variables ('covariates') and the elements of the process model, to account for the dynamic changes in observations over time. The two elements of the process model are recruitment of each new generation and survival from one life stage to the next. In the observation model, bias parameters account for imperfect detections that can vary over time. When abundance is predicted to affect survival or the abundance of the next annual cohort of fish, that is referred to as 'density dependence'. The covariates that are included in these modeling tools are those that were found to best predict the population dynamics modeled in the SSMs (Polansky *et al*. 2021, entire particularly its Supplemental Information). One limitation of each SSM is the mismatch between the model temporal scale (1 to 3 months) and the weekly scale of real-time water operations management. Observations of delta smelt in fish surveys are sparse, requiring aggregation of data over several weeks to limit the observation error resulting from noisy catch data, when constructing indices of abundance to fit the SSMs. The SSM predictions of recruitment or survival at a given flow can only coarsely inform water operations decisions, because many combinations of daily flows may result in the same 1 to 3-month average.

In our effects analysis we have reviewed and applied the published findings and Reclamation's adaptations of three delta smelt SSMs, a hybrid statistical and agent-based delta smelt life cycle model developed by the Service, and a longfin smelt DPS autoregressive model developed by consultants for Reclamation:

- The Service's "general" Delta Smelt Life Cycle Model (LCMG; Polansky *et al.* 2021; 2023; 2024). This is a statistical (state-space) life cycle model that uses covariates to predict 'recruitment' of a new generation and survival across three subsequent life stages to predict the number of adults for the next generation. It was originally fit to data from 1994-2015 (Polansky *et al.* 2021, p. 7), then expanded to 1990-2015 and more fully sensitivity tested by Polansky *et al.* (2023, entire). Most recently, it was used in a hypothetical predictive mode to evaluate the relative importance and impact frequency of the covariates used to model recruitment and survival (Polansky *et al.* 2024, entire). This most recent paper can be thought of as a 'thought' experiment and we review its results where appropriate in our effects analysis.

- The BA *Appendix F, Attachment F* describes an updated version of the SSM originally described in Maunder and Deriso (2011, pp. 1286-1292), which Reclamation called the 'MDR' model. This model is conceptually similar to the LCMG, and Reclamation used the same abundance and covariate data in the MDR that Polansky *et al*. (2021) used in the LCMG. These two models are conceptually similar in that entrainment effects are indirectly accounted, through entrainment covariates rather than directly accounting for entrainment using estimates of the total number of fish entrained.

- The Service's Delta Smelt Life Cycle Model with Entrainment (LCME; Smith *et al*. 2021, entire). This is a second state-space life cycle model that builds on the analytical foundation provided by LCMG. It models the same 'recruitment' of each new generation but then models seven subsequent survivals to predict the number of adults for the next generation. The finer resolution of the life cycle allows for evaluation of entrainment effects in up to four non-overlapping life stages (see *Status of the Species* for further details). Loss to entrainment in the South Delta is modeled separately from other sources of mortality in these four life stages and 'natural mortality' or more properly, mortality due to everything other than entrainment in exported water is calculated for six of the seven modeled life stages. This allows for direct estimation of the population-level effects of entrainment which is not possible using LCMG. The LCME was originally fit to data from 1995-2015 (Smith *et al*. 2021, p. 1010). Reclamation and the Service collaborated on the use of LCME for the biological assessment (*Appendix F, Attachment X*). The model was applied to more CalSim 3 alternatives than were required for our effects analysis, so we extracted and summarized the relevant results.

- For the longfin smelt DPS, we used the results of a Bayesian regression model provided by Reclamation (BA Appendix J: Spring Delta Outflow, Attachment J: Longfin Smelt Outflow). This tool is a simple life cycle model in the form of an 'autoregressive' model. Autoregressive models include indices of prior abundance to help predict abundance in the next generation. The model described in the cited Attachment has not been published but is based on previously published analogs like Mac Nally *et al*. (2010), Maunder *et al*. (2015), and Nobriga and Rosenfield (2016).

<u>Climate Change</u>

The CalSim 3 modeling represents climate conditions using predictions from 40 global climate projection models for the year 2022±15 years (*BA Appendix F Section 3.1*). In other words, it is an approximation of the current climate out to about the year 2037. Model simulations included 15 cm (6 inches) of assumed sea level rise. The quantitative portion of our effects analysis in this BiOp is therefore limited to this timeframe. These expected near-term climate effects are carried through into 'downstream' models like the LCMs described above. Concurrent expected changes in air temperature (e.g., Larson *et al*. 2023, their Fig. 2B) have not been modeled so we do not have directly applicable quantitative estimates of what expected trends in water temperature will be. We do not have a reliable method to estimate project-related changes on water temperature to compare these metrics against. The best available information we are aware of indicates that PA effects on water temperature in the upper estuary are smaller than air temperature effects and mainly limited to the upper margins of the Delta (Wagner *et al*. 2011, entire; Vroom *et al*. 2017, entire).

Modeling of the Proposed Action

There were seven CalSim3 scenarios run using 2004-2013 level of development as described in *BA Appendix F*; six were explicitly summarized in *BA Appendix F: Modeling, Section 1-2, Callouts Tables*. The seventh was a version of Alternative 2 version 1 that included modeling the use of Temporary Urgency Change Orders (TUCO) similar to the No Action Alternative (NAA). Detailed descriptions of the scenarios can be found in *BA Appendix F – Modeling section 1-1 CalSim 3, DSM2, and HEC5Q Modeling Simulations and Assumptions*. Several times in the past decade, Reclamation and DWR have petitioned the State Water Resources Control Board (SWRCB) for temporary relaxation of the salinity standards specified in D-1641 using a Temporary Urgency Change Petition process (TUCP). These requests were generally granted as TUCOs, so the Service considers their future use reasonably certain to occur. Reclamation requested conference and consultation on Alternative 2; therefore, our analysis assumes the four Alternative 2 model scenarios represent the best model approximation of the PA. In our effects analysis, we analyze results of all four Alternative 2 variations. We used the modeling that was provided in BA Appendix F on November 28, 2023.

Appendix F: Modeling, Section 1-2 Callouts Tables of the BA contains the modeling assumptions that were used for each modeled scenario. Our analysis, and the resulting ecological condition that results that serves as the surrogate as described in the Incidental

Take Statement of this BiOp, is premised on the PA being implemented consistent with these modeling assumptions.

Where Reclamation has made changes to the PA that are not reflected in the CalSim 3 modeling our analysis describes those changes and addresses them qualitatively when we expect actual conditions to be different than what was modeled. These qualitative analysis elements are used to address changes from the PA model run to the PA as proposed, as well as changes to the PA and potential real-time conditions that could not be modeled accurately using a monthly time-step.

There are some elements of the PA that are addressed under the framework programmatic approach that will be quantitatively modeled at a future date. These include elements that are likely to impact hydrodynamics and water quality in the Delta, including but not limited to drought barriers, changed points of diversion (such as the Delta Conveyance Project) and the Sites Reservoir project. Our analyses of these elements are likewise qualitative; future quantitative analysis of each of these elements will be addressed in subsequent consultations as described above and will include LTO as their modeled baseline condition.

Spring Delta Outflow/Healthy Rivers and Landscapes Program

Reclamation and DWR propose to augment delta outflow during March through May, emphasizing April and May, through the Healthy Rivers and Landscapes Program (HRL), which is currently under development. For the first two years (HRL pre-adoption period) of LTO implementation (or until and if the HRL program is incorporated into the SWRCB Water Quality Control Plan (WQCP), whichever comes first), Reclamation and DWR propose to implement the CVP and SWP "foregone exports" portion of the March 2022 Memorandum of Understanding signed by the HRL parties (Table 3-12 of BA Section 3.7.5). Thereafter, Reclamation and DWR propose to operate consistent with the HRL only if the SWRCB approves the HRL, as substantially proposed by the HRL parties, and the parties execute or are in the process of executing the agreements associated with the HRL and the SWRCB incorporates the HRL as proposed into their WQCP.

In its application for an incidental take permit for LTO under the California Endangered Species Act, DWR has accounted for an SWP portion of the HRL program focused on Above-Normal, Below-Normal, and Dry water year types (ITP application Table 16) and included an HRL pre-adoption implementation plan that can be implemented in one of two ways to generate conditions in the Delta similar to what was in CDFW's 2020 ITP condition of approval 8.17 (ITP application Section 3.3.3.2). The pre-adoption HRL actions describe plans to increase Delta outflow via temporary reduction of exports from the South Delta. Reclamation proposes to implement additional export reductions if the SWRCB approves the HRL and the parties execute or are in the process of executing the agreements. DWR proposes to implement additional outflow beyond the first two years of ITP implementation even if the HRL plan is not adopted before the pre-adoption period ends. DWR's pre-adoption proposal is included in the PA for this consultation; however, it was not modeled under Alternative 2 version 2 so there was no information provided to support quantitative analysis of this component of the PA. Because DWR's proposal is reasonably certain to occur and is part of coordinated operations, our analysis addresses this action in a qualitative manner.

Reclamation modeled four variations of Alternative 2. The modeling was done prior to the Voluntary Agreement (VA) process being changed to the HRL; therefore, the modeling refers to VAs, but this change in the name of the program does not affect the results. For consistency, we will use "HRL" thought the document when referring to this program. The four modeled versions of the PA are: without HRL (version 1), without HRL and with TUCPs (version 1 TUCP), with Delta HRL (meaning outflow augmentation using only export cuts; version 2), and with full HRL implementation (version 3). Our understanding is that the version 2 scenario includes the pre-adoption portion of the Spring Delta Outflow element of the PA; therefore, since this represents the PA that Reclamation requested conference and consultation on, we analyzed the pre-adoption portion as a standard consultation though as mentioned above, our analysis covers all four variations of Alternative 2. This enabled us to quantitatively compare variations that included the HRL, included partial HRL implementation, as well as a variation that included hypothetical TUCOs. We treated the NAA as the modeled baseline, which along with other activities contributing to the current status of the species that were not incorporated into the modeling, makes up the entirety of the Environmental Baseline for this BiOp.

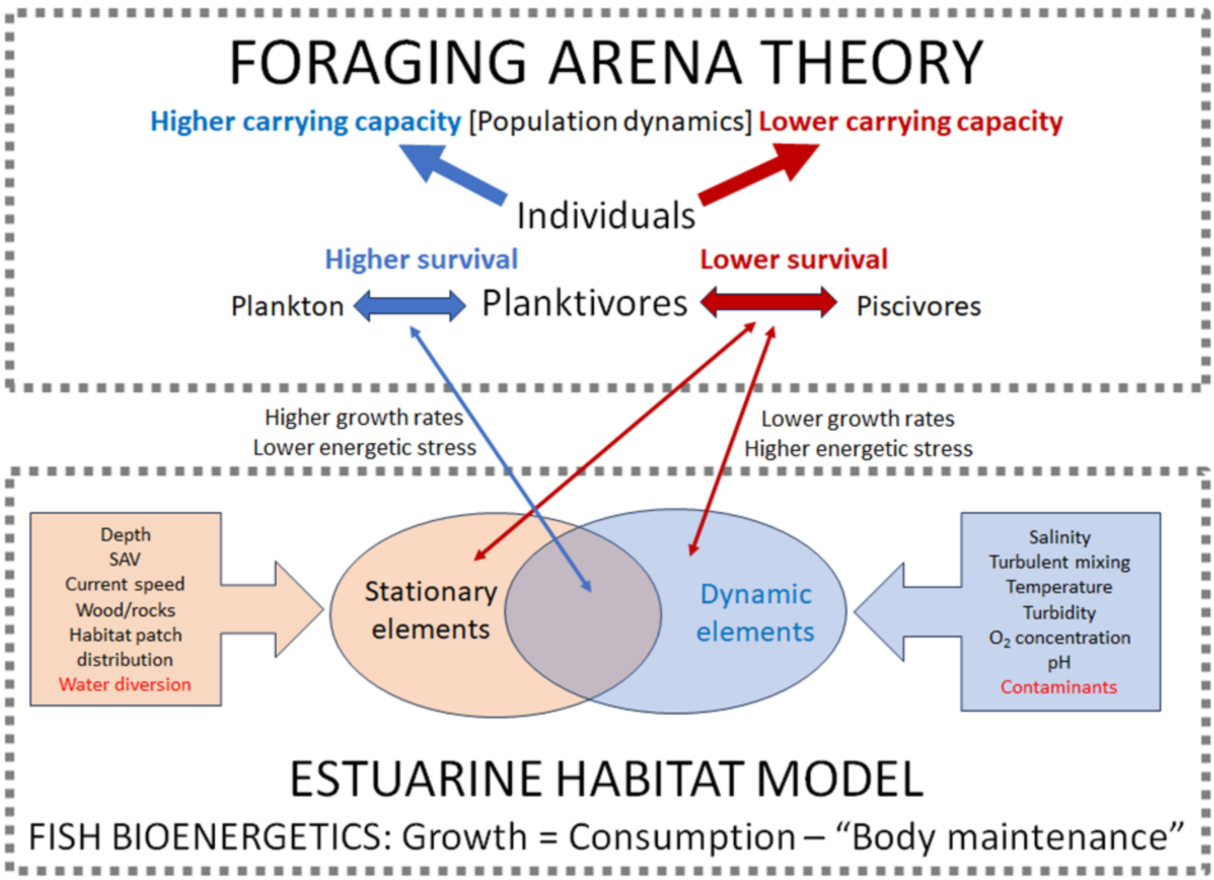
Implementation of all of the HRL pre-adoption period actions is dependent on a future action by SWRCB and the HRL parties. Because specific details regarding accounting, governance, and other HRL program elements are likely to change as they are further refined, the Service cannot analyze the specific details of where, when and how the listed species and critical habitat are likely to be affected. Therefore, because implementation is dependent on future approvals and details are likely to change, we analyzed the HRL pre-adoption period as a framework programmatic action.

If the HRL process is incorporated into the WQCP and the HRL parties execute the agreements, the federal action agency will request subsequent consultation including details about how coordinated operations will be implemented to comply with the WQCP including the HRL program. Reclamation will follow the framework programmatic consultation process described in this section above. If the SWRCB does not approve the HRL or the parties do not execute the agreements in order to implement the HRL, reinitiation of this consultation may be necessary.

Fish Habitat Conceptual Model

The way in which aquatic habitats do or do not support fish species and life stages is a complex set of topics in fisheries ecology and conservation biology. There are several established models that when blended conceptually can help convey how a potentially large number of factors interact and intersect to define habitats for fish and ultimately influence their population dynamics (Figure 1-1). This conceptual model is a visual simplification of quantitative research: estuarine habitat (reviewed by Peterson 2003, entire), foraging arena theory (reviewed by Ahrens *et al*. 2012, entire), and fish bioenergetics (reviewed by Deslauriers *et al*. 2017, entire). We describe this integrated set of conceptual models here in a general sense, then apply them to delta smelt and longfin smelt in more detail in sections pertinent to each species. We note that the blended conceptual models as depicted are also a qualitative approximation of the quantitative modeling framework built and deployed for the Mississippi River Delta by DeMutsert *et al.* (2012; 2017, entire). This complexity cannot be modeled explicitly in the SSMs described above so we rely on literature review to cover specifics for delta smelt and the longfin smelt DPS.

Figure 1-1: Conceptual model of factors interacting to affect estuarine fish habitat



In tidal river estuaries like the Bay-Delta the habitat of every fish species and often life stage is defined by a unique suite of stationary and dynamic features (Peterson 2003, entire). The greater the overlap of the needed stationary and dynamic habitat elements, the better that species or life stage is expected to perform on average. What conditions need to overlap is different for every species and life stage and for some the stationary habitat elements may be more important while for others the dynamic elements may be more important. Like many estuaries, the Bay-Delta is highly developed and has both stationary (water diversions) and dynamic (contaminants) habitat attributes that are never positive attributes of fish habitat (shown in Figure 1-1 in red font). These are called out because it is generally best if these do not overlap with otherwise good habitat features, though of course they sometimes do.

Both the underwater 'landscape' and the freshwater flow regime of the Bay-Delta have been substantially altered (Andrews *et al*. 2017, entire). The contemporary estuary is deeper due to dredging for shipping, disconnected from most of its marsh-floodplain due to agriculture and other land uses, and it has lower freshwater inflows with an altered seasonal timing. Freshwater inflows and outflows are lower in the winter-spring and higher in parts of the summer-fall than they were naturally. Climate change is expected to alter the flow regime further generating a flashier system with even greater interannual variability than California's already high year to year variation in precipitation and runoff (Dettinger *et al*. 2016, entire).

The concept of overlapping elements in the estuarine habitat conceptual model links to foraging arena theory through the latter's exchange rates that describe the vulnerability of planktonic prey to planktivorous fish and the vulnerability of planktivorous fish to their predators (Figure 1-1). If a hypothetical planktivorous fish is residing in a habitat with strong overlap of its needed stationary and dynamic habitat features, it should have higher exchange rates between it and its planktonic prey and lower exchange rates between it and its predators than if it were in a place where needed habitat overlap was lacking. The more frequently individuals of this hypothetical fish species or life stage have their habitat needs met, the more frequently they will experience foraging arena exchange rates that support relatively high productivity and relatively low loss leading to a higher ecosystem carrying capacity.

Fish bioenergetics further links habitat suitability and foraging arena theory (Figure 1-1). Nearly all fish are completely ectothermic or 'cold-blooded' animals. As such their metabolisms and life histories conform to the seasonal and interannual temperature regimes they have experienced and adapted to over evolutionary time scales (Holt and Jørgensen 2015, entire; Palomares *et al.* 2022, entire; Pauly and Liang 2022, entire).

Therefore, water temperature influences almost every aspect of a fish's life including when it can spawn, how much food it needs to eat to grow, how it behaves, how susceptible it is to disease and contaminants, and even how long it may live. The temperature dependence of fish metabolism and growth rates is codified in fish bioenergetics models, which predict growth from the amount of food consumed minus the calories needed to support basic body maintenance (i.e., metabolism), all as mathematical functions of water temperature (e.g., Jørgensen *et al*. 2016, entire; Railsback 2021, entire). This centrality of temperature in fish life histories and ecological performance also makes bioenergetics models useful for predicting how climate change may affect species in the coming decades through both physiological and food web pathways (Holt and Jørgensen 2015, entire).

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2. Proposed Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by federal agencies (50 CFR 402.02).

Reclamation operates the CVP for the congressionally authorized purposes of (1) river regulation, improvement of navigation, and flood control; (2) irrigation and domestic uses and fish and wildlife mitigation, protection, and restoration; and (3) power and fish and wildlife enhancement. DWR operates the SWP for the primary purpose of water supply deliveries and flood control, and the SWP provides additional benefits including power generation and environmental stewardship. Public Law 99-546 authorized the 1986 Coordinated Operations Agreement, which sets procedures for Reclamation and DWR to share joint responsibilities for meeting Delta standards and other legal uses. Operation of the CVP and SWP also provide recreation and water quality benefits.

The proposed action covers CVP service areas and the operation of CVP dams, power plants, diversions, canals, gates, and related federal facilities located on the watersheds of Clear Creek; the Sacramento, American, Stanislaus, and San Joaquin rivers; and CVP and SWP facilities in the Sacramento–San Joaquin Delta and Suisun Marsh and Bay.

The proposed action is organized as follows:

- Watersheds: basin-by-basin description of facilities and the proposed operation for fish and wildlife, water supply, and power generation including proposed conservation measures to promote the recovery and/or to minimize or compensate for adverse effects of operation on federally listed species.

- Monitoring: the long-term evaluation of performance to assess overall effectiveness over time. Although each watershed has unique requirements, Reclamation and

DWR integrate monitoring across watersheds; therefore, monitoring is organized in a single section.

- Special Studies: science-based efforts to address uncertainties in the proposed action that affect a reasonable balance among competing demands for water, including the requirements of fish and wildlife, agricultural, municipal, and industrial uses of water, and power contractors to inform subsequent decision making.

- Drought: actions to recognize extreme dry conditions may occur during operations. The boom-and-bust nature of California hydrology and the resulting effect on species warrants special consideration for operation during droughts. Although each drought is unique, contingency planning can facilitate a response.

- Governance: ongoing engagement by Reclamation and DWR with USFWS, NMFS, the California Department of Fish and Wildlife (CDFW), interested parties, and the public following completion of the biological opinions and a Record of Decision.

- Adaptive Management: science and decision analytic-based approach to evaluate and improve actions, with the aim to reduce uncertainty over time and increase the likelihood of achieving and maintaining a desired management objective. The process described in the LTO Adaptive Management Program is key to the successful implementation of coordinated operations and related actions that minimize the effects of operations. Implementation of the program will entail additional monitoring and research to carry out elements of the program under the direction of a steering committee. The actions under the program are categorized into bins correlated with their anticipated timeframe for completion and possible implementation into decision-making tools or in some cases, as future actions. The program includes a description of the purposes and scope of the program, governance structure, decision-making process, and initial list of actions.

The full proposed action, including the Adaptive Management Plan and associated appendices, from the Final Biological Assessment is incorporated by reference into this BiOp. See *Appendix 2: Proposed Action*.

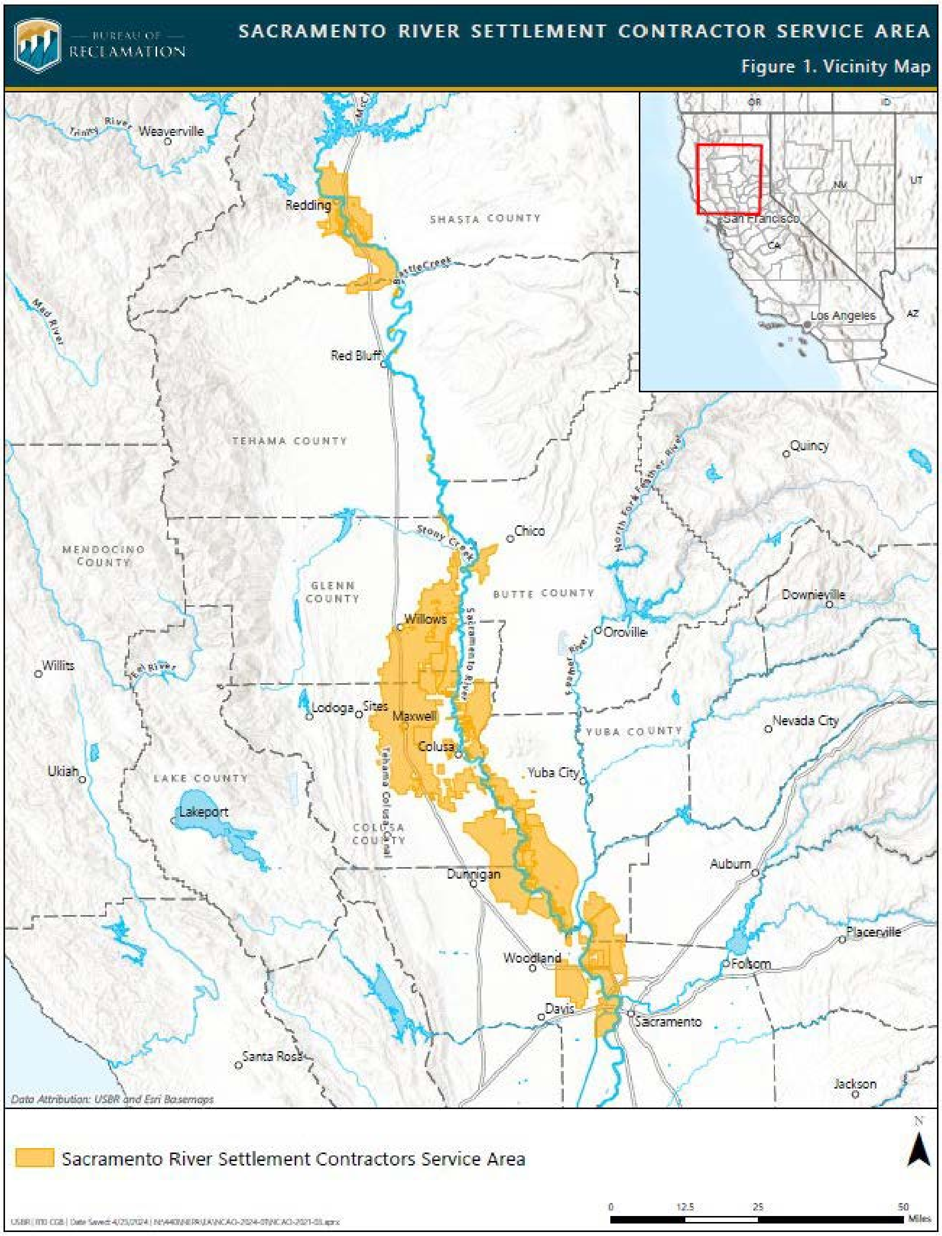
As previously stated in the *Consultation Approach* section above, there are components of this BiOp that are fully analyzed that do not require subsequent approvals and consultation. Unless otherwise stated, it is assumed that these actions will be handled in this manner. The Proposed Action also has components that are treated programmatically. The ITS may or may not cover these programmatic actions. Programmatic actions in this BiOp are listed in the attached Effects Tracking Table.

3. Action Area

The Action Area is defined as all areas to be affected directly or indirectly by the federal action and not merely the immediate area involved in the action (50 CFR 402.02). The Action Area for this BiOp is based on the descriptions of the components of the PA as described in the BA, including some for which exact locations and extent of effects are not yet known. These components are addressed programmatically and will either rely on existing consultations or be subject to subsequent consultation. This definition of the Action Area is based on our current understanding of the extent of activities proposed by Reclamation. This encompasses areas in which effects to Service-jurisdictional species and critical habitat may occur, and excludes areas described in the BA where only effects to NMFS-jurisdictional species and critical habitat may occur.

The Action Area encompasses the following reservoirs, rivers, and the land between the levees adjacent to the rivers: (1) Sacramento River from Shasta Lake downstream to and including the Sacramento–San Joaquin Delta; (2) Clear Creek from Whiskeytown Reservoir to its confluence with the Sacramento River; (3) American River from Folsom Reservoir downstream to its confluence with the Sacramento River; (4) Stanislaus River from New Melones Reservoir to its confluence with the San Joaquin River; (5) San Joaquin River from Friant Dam downstream to and including the Sacramento–San Joaquin Delta; (6) Suisun Marsh, (7) San Pablo and San Francisco bays, and (8) the area of the Pacific Ocean that overlaps with the range of the longfin smelt DPS. The Action Area also includes the Sacramento River Settlement Contractors Service Area to account for effects to giant garter snake, as depicted in Figure 3-1.

Figure 3-1: SRSC portion of the Action Area.



4. Analytical Framework for the Jeopardy Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to jeopardize the continued existence of listed species. "Jeopardize the continued existence of" means to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species (50 CFR § 402.02).

The jeopardy analysis in this BiOp considers the effects of the proposed Federal action, and any cumulative effects, on the rangewide survival and recovery of the listed and proposed species. It relies on four components: (1) the *Status of the Species*, which describes the current rangewide condition of the species, the factors responsible for that condition, and its survival and recovery needs; (2) the *Environmental Baseline*, which analyzes the current condition of the species in the Action Area without the consequences to the listed species caused by the proposed action, the factors responsible for that condition, and the relationship of the Action Area to the survival and recovery of the species; (3) the *Effects of the Action*, which includes all consequences that are caused by the proposed Federal action, including the consequences of other activities that are caused by the PA but that are not part of the action; and (4) the *Cumulative Effects*, which evaluates the effects of future, non-Federal activities in the Action Area on the species. The *Effects of the Action* and *Cumulative Effects* are added to the *Environmental Baseline* and in light of the status of the species, the Service formulates its opinion as to whether the proposed action is likely to jeopardize the continued existence of the listed and proposed species.

5. Analytical Framework for the Adverse Modification Determination

Section 7(a)(2) of the Act requires that Federal agencies ensure that any action they authorize, fund, or carry out is not likely to destroy or to adversely modify designated critical habitat. "Destruction or adverse modification" means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species (50 CFR 402.02).

The adverse modification analysis in this BiOp relies on four components: (1) the *Status of Critical Habitat*, which describes the current range-wide condition of the critical habitat in terms of the key components (i.e., essential habitat features, primary constituent elements, or physical and biological features) that provide for the conservation of the listed species, the factors responsible for that condition, and the intended value of the critical habitat overall for the conservation/recovery of the listed species; (2) the *Environmental Baseline*, which analyzes the current condition of the critical habitat in the Action Area without the consequences to designated critical habitat caused by the proposed action, the factors responsible for that condition, and the value of the critical habitat in the Action Area for the conservation/recovery of the listed species; (3) the *Effects of the Action*, which determines all consequences to designated critical habitat that are caused by the proposed federal action, including the consequences of other activities that are caused by the PA but that are not part of the action, on the key components of critical habitat that provide for the conservation of the listed species, and how those impacts are likely to influence the conservation value of the affected critical habitat; and (4) *Cumulative Effects,* which evaluate the effects of future non-federal activities that are reasonably certain to occur in the Action Area on the key components of critical habitat that provide for the conservation of the listed species and how those impacts are likely to influence the conservation value of the affected critical habitat. The *Effects of the Action* and *Cumulative Effects* are added to the *Environmental Baseline* and in light of the status of critical habitat, the Service formulates its opinion as to whether the action is likely to destroy or adversely modify designated critical habitat. The Service's opinion evaluates whether the action is likely to impair or preclude the capacity of critical habitat in the Action Area to serve its intended conservation function to an extent that appreciably diminishes the rangewide value of critical habitat for the conservation of the listed species. The key to making that finding is understanding the value (i.e., the role) of the critical habitat in the Action Area for the conservation/recovery of the listed species based on the *Environmental Baseline* analysis.

6. California Least Tern

a. Status of the Species

The California least tern is a subspecies of the least tern. The California least tern was federally listed as endangered on October 13, 1970. A detailed account of the taxonomy, ecology, and biology of the species is presented in the approved *Revised California Least Tern Recovery Plan* on April 2, 1980, https://ecos.fws.gov/docs/recovery_plan/850927_w%20signature.pdf (Service 1985). For the most recent comprehensive assessment of the species' range-wide status, please refer to the 2020 California least tern 5-year review at https://ecos.fws.gov/docs/tess/species_nonpublish/3520.pdf (Service 2020). No change in the species' listing status was recommended in this 5-year review. Threats evaluated during that review and discussed in the final document have continued to act on the species with loss of habitat and degradation being the most significant effect.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

Environmental Baseline

Nesting has occurred sporadically with an increase in inland sites from the Bay Area toward the Delta and Central Valley (Service 2006). Low detections of California least terns have been documented in the Action Area within Suisun Marsh (CDFW 2024). A breeding colony has been documented on the east side of Montezuma Slough near Collinsville in 2006, at a Montezuma Wetlands dredge disposal site. After initially being sighted at Montezuma in 2005, California least terns nested at the site in 2006 and 2007. In summer 2005, approximately 15 to 20 California least terns were observed on a shell mound in Cell 3/4. The next year, California least terns nested on another shell mound in Cell 3/4. The California least terns nested successfully at the project site in 2006 and have nested each year since then. Table 6-1 below presents the number of California least terns observed at the site.

Table 6-1: Montezuma Wetlands California Least Tern Surveys 2012–2023

Year	Number of Surveys Conducted	Number of Sub-colonies	Single-visit high count of nests[1]	Single-visit high count of chicks[1]	Single-visit high count of fledglings[1]	Number of nests[2,3]	Estimated number of pairs[2]
2012	19	2	18	15	13	31	18
2013	22	3	22	13	2	29	25
2014	24	2	11	4	3	16	15–16
2015	18	2	7	6	0[4]	16	12–14
2016	19	1	3	3	1	6	4–6
2017	30	2	4	5	3	9	5–7
2018	18	3	11	6	0[4]	18	14–15
2019	26	3	7	9	2	15	10–12
2020	38[5]	1	17	14	3	29	22–25
2021	33[5]	2	9	7	4	15	14–19
2022	14	1	7	0	0	7	7
2023	19	2	16	14-20	5	30	14-29

1 Single-visit high counts provide an absolute minimum number of nests, chicks, and fledglings during years when more-accurate data were not available.
2 Until 2012, subcolonies were not visited with enough frequency to provide reasonably accurate estimates; beginning in 2012 increased frequency of visits enabled calculation of better estimates, but they may still be underestimates in some years.
3 Includes all nests, eggs, chicks, and fledglings detected, including those that later failed or died.
4 Fledgling counts are sometimes estimated by using a formula, but fledgling numbers at Montezuma are generally known and not estimated. Note that this number reflects the number of chicks known to have recruited (joined the adult population to migrate); it does not include chicks that may have begun to fly-hop but did not survive to recruit.
5 Construction monitoring tasks enabled additional visits these years. Number of surveys has varied over the years by budget and by how long terns remain on site. Nesting season has varied from a few weeks to nearly 4 months in duration.
(Pers. Comm Cassie Pinnell 2024)

Numerous section 7 consultations have been done in the Suisun Marsh in the Action Area with a majority of the consultations being related to on-going maintenance activities or conversion of managed marsh to another use, such as tidal marsh restoration. The June 2013, *Biological Opinion on the Proposed Suisun Marsh Habitat Management, Preservation, and Restoration Plan and Project-Level Actions in Solano County, California* (08ESMF00-2012-F-0602-2) was issued to the Corps to cover projects that fall under the Corps' Regional General Permit, their Letters of Permission, or individual permits in the Suisun Marsh. Example tidal marsh restoration projects that have been consulted on in the Action Area include Tule Red (08FBDT00-2016-F-0071), Blacklock (1-1-06-I-1880), and Montezuma Wetlands (1-1-99-F-12 and numerous reinitiations).

Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

Depending on the nature, scope, location, and timing of restoration actions associated with individual restoration projects, there is a potential to adversely affect California least terns during implementation of construction, long-term management, or monitoring activities. Construction activities may disturb California least terns. If present, California least terns moving through the Suisun Marsh and surrounding areas seeking out suitable nesting habitat or to forage in the bays, sloughs, and managed wetlands individuals may be affected or disturbed altering their normal behavior. Restoration construction may require the use of heavy equipment such as excavators, back hoes, bulldozers, and dump trucks in order to reconstruct interior site elevations, create levees, and breach levees. Noise and vibrations created by heavy equipment may also temporarily disturb individuals. However, due to their highly mobile nature and ability to forage in a variety of habitats it is unlikely that these activities will cause substantial disturbance to California least terns.

It is expected that construction activities would not significantly affect foraging habitat because open water habitat is abundant in the Suisun Marsh. Conversion of suitable habitat in managed wetlands to tidal wetlands would result in an increase in foraging habitat because the tidal wetland restoration areas would be subject to tidal action and therefore would be inundated permanently or more frequently than under existing managed wetlands. As the restored areas evolve into a functioning tidal wetland, it will continue to provide suitable habitat for the California least tern.

As demonstrated in Table 16 of Section 3.7.9 of the BA, most of the acreage has been constructed or is under construction. These actions are addressed programmatically in this consultation, so further detail about adverse effects and benefits, and any incidental take, already has or will be addressed in subsequent consultation prior to implementation. As Chipps Island Tidal Habitat Restoration Project is the last remaining proposed restoration project, this framework would include tiering or appending to the existing Suisun Marsh

Habitat Management, Preservation, and Restoration Plan BiOp and implementing the Conservation Measures outlined in that BiOp.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The Suisun Marsh Salinity Control Gates (SMSCG) are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. Depending on the timing of the proposed operations, SMSCG operations may overlap with the California least tern late breeding season and potential presence in the Suisun Marsh to forage. California least terns hunt smaller fish such as silversides, perch, anchovies, small crustaceans, and other smaller fish (Service 1985). SMSCG reoperations are expected to temporarily lower marsh salinities creating a potential shift in their prey base availability in Suisun Marsh. However, because foraging is readily available in the Suisun Marsh and the restoration and enhancement projects are expected to increase food quality of habitat available to the California least tern, adverse effects to California least terns are not expected to occur. If through planning and implementation of the project-level activities, adverse effects to the California least tern are realized and have not been analyzed, reinitiation will be necessary.

Effects to Recovery

Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to California least terns in order to gain an increase in long-term habitat benefits, thereby assisting in the recovery of this species. Therefore, we conclude that the PA would not negatively affect, and may contribute to, recovery of the California least tern.

Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect California least tern. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the California least tern.

Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the California least tern.

Reproduction

California least terns are known to breed and nest at one location in the Suisun Marsh. As the Chipps Island Tidal Habitat Restoration Project is the last remaining restoration action to tier from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp it will be consistent with the conservation measures identified in that BiOp which include nest buffers during the breeding season minimizing effects to nesting terns. Therefore, the PA is not expected to negatively affect California least tern reproduction rangewide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

With implementation of the PA, no mortality or injury of individuals are expected to occur from tidal marsh restoration. Restoration actions would contribute to the recovery of California least tern by creating more foraging habitat for California least terns. Therefore, the PA is not expected to reduce the number of California least terns.

Distribution

The number of California least terns in the Suisun Marsh are relatively low in relation to the species' population numbers range wide. Although there is the potential to disturb individuals in a way that may result in altered normal behavior, it is still expected that these activities will not cause substantial disturbance to California least terns. California least terns are highly mobile birds with the ability to forage in a variety of habitats throughout the Suisun Marsh. Implementation of conservation measures in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp will minimize the potential for disturbing California least terns. Therefore, we do not expect the PA to reduce the species' distribution relative to its range-wide condition.

Conclusion

After reviewing the current status of California least tern, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- The number of California least terns likely to be affected by the PA will be low relative to the number of California least terns range wide.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the California least tern long-term.

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Personal Communication

Email from Cassie Pinnell (Vollmar Natural Lands Consulting) to Andrew Raabe (Service). May 7, 2024.

7. California Ridgway's Rail

a. Status of the Species

The California Ridgway's rail was federally listed as endangered on October 13, 1970. Information about the California Ridgway's rail biology and ecology is available in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*, available at: https://ecos.fws.gov/docs/recovery_plan/TMRP/20130923_TMRP_Books_Signed_FINAL.pdf (Service 2013a). For the most recent comprehensive assessment of the species' range-wide status, please refer to the California Ridgway's rail 5-year Review, available at: https://ecos.fws.gov/docs/five_year_review/doc6592.pdf (Service 2020). No change in the species' listing status was recommended in this 5-year review. Threats evaluated during that review and discussed in the final document have continued to act on the species with loss of habitat being the most significant effect.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

c. Environmental Baseline

On-going rail monitoring in the Suisun Marsh by the CDFW has shown sporadic detections of California Ridgway's rails within the Action Area in the past 22 years (16 individuals sighted since 2002). This species has been detected at several locations in Suisun Marsh, including occurrences along Suisun Slough, Cutoff Slough, Hill Slough, Goodyear Slough, Rush Ranch, and Ryer Island (Service 2013b). Given the variable history of California Ridgway's rail presence in Suisun Marsh, the marsh may represent crucial habitat for this critically endangered subspecies of Ridgway's rail (CDFW 2016). Suisun Marsh has very limited high marsh vegetation which the California Ridgway's rail require. According to the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*, one of the criteria for California Ridgway's rail to be downlisted is to have a minimum of 5,000 acres of contiguous high quality tidal marsh habitat with well-developed channel systems and high-tide refugial/escape cover at the high marsh/upland transition zone and or inner-marsh of the Western Grizzly and Suisun Bays and marshes of Suisun Hill and Cutoff Slough (within the Suisun Bay Recovery Unit) (Service 2013a, Service 2013b).

Tidal marshes are fragmented throughout Suisun Marsh. By the end of 2023, a total of 2,587 tidal acres have been restored from managed wetlands within Suisun Marsh (DWR 2024). The vast majority of California Ridgway's rails do not move more than one kilometer, though post-breeding dispersal may occur in fall and early winter (Albertson & Evens 2000). The last time a California Ridgway's rail was detected by CDFW surveys was in 2011 at Rush Ranch (CDFW 2017). The vast majority of the California Ridgway's rails are found in the San Pablo and San Francisco Bay, downstream of Suisun Marsh, where water salinities are higher. Salinity influences other variables, such as vegetation and invertebrates. Suisun Marsh is generally too fresh to support vegetation, such as *Spartina foliosa*, which may also contribute to low California Ridgway's rail densities.

Numerous consultations have been done in the Suisun Marsh in the Action Area with a majority of the consultations being related to on-going maintenance activities or conversion of managed marsh to another use, such as tidal marsh restoration. The June

2013, *Biological Opinion on the Proposed Suisun Marsh Habitat Management, Preservation, and Restoration Plan and Project-Level Actions in Solano County, California* (08ESMF00-2012-F-0602-2) was issued to the Corps to cover projects that fall under the Corps' Regional General Permit, their Letters of Permission, or individual permits in the Suisun Marsh. Example tidal marsh restoration projects that have been consulted on in the Action Area include Tule Red (08FBDT00-2016-F-0071), Blacklock (1-1-06-I-1880), and Montezuma Wetlands (1-1-99-F-12 and numerous reinitiations).

d. Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

Depending on the nature, scope, location, and timing of restoration actions associated with individual restoration projects, there is a potential to adversely affect California Ridgway's rails during implementation of construction, long-term management, or monitoring activities.

California Ridgway's rails do not occupy managed seasonal wetlands; therefore, flooding managed wetlands for the purpose of restoration would not affect California Ridgway's rails. California Ridgway's rails inhabit suitable tidal wetlands and tidal sloughs in the Suisun Marsh.

If present, restoration activities in these areas could potentially disrupt California Ridgway's rail breeding and foraging in tidal wetlands. Restoration construction may require the use of heavy equipment such as excavators, back hoes, bulldozers, and dump trucks in order to reconstruct interior site elevations, create levees, and breach levees. Ground disturbing activities may result in disturbance, harm, injury, or death of California Ridgway's rail, nests, or their young through the loss or degradation of their habitat, crushing by equipment and machinery, loss of breeding activity, nest abandonment, or increased risk of predation. Individual Ridgway's rails may be disturbed by noise and vibrations associated with the use of heavy equipment used within or adjacent to habitat disrupting feeding, sheltering, or breeding activities. California Ridgway's rail that are disturbed may be flushed from protective cover or their territories exposing the rails to predators. The level of disturbance would be exacerbated if the construction activities occurred during the rail's breeding season resulting in loss of breeding activity or if the work occurred during an extreme high tide when the California Ridgway's rails are most likely to escape into adjacent areas to seek upland refugia cover. Displaced California Ridgway's rails may have to compete for resources in occupied habitat and may be more vulnerable to predators. Disturbance during the breeding season may disrupt breeding or cause nest abandonment resulting in the mortality of all the eggs and chicks in the nest. With implementation of the conservation measures in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp, impacts to individuals will be minimized or avoided.

There could be a loss of foraging habitat throughout the Suisun Marsh as a result of construction-related activities. However, restoration activities are expected to be minor, temporary losses and not substantial given the amount of foraging habitat remaining. Conversion of managed wetlands to tidal wetlands would result in increased California Ridgway's rail breeding and foraging habitat. As the restored areas evolve into a functioning, vegetated tidal wetland, it is expected to provide permanent, sustainable, suitable habitat for the California Ridgway's rails. Habitat levees, if part of the restoration design, would provide refugia from high water events. Temporary disturbance of individual California Ridgway's rails and their habitat would occur initially, but the long-term effects would be increased suitable tidal marsh habitat which would benefit the entire California Ridgway's rail population.

These actions are addressed programmatically in this consultation, so further detail about expected adverse effects and benefits, and any incidental take, has already been or will be addressed in subsequent consultation prior to implementation. As Chipps Island Tidal Habitat Restoration Project is the last remaining proposed restoration project, this framework would include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and implementing the Conservation Measures outlined in that BiOp.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. Depending on the timing of the proposed operations, SMSCG operations may overlap with the California Ridgway's rail late breeding season and potential presence in the Suisun Marsh. California Ridgway's rails hunt mussels, crabs, and clams (Service 2013a). SMSCG reoperations are expected to temporarily lower marsh salinities which may create a potential shift in their prey base availability and distribution in Suisun Marsh, but the extent to which this may occur is unknown. Adverse effects to California Ridgway's rails are not expected to occur. If through planning and implementation of the project-level activities, adverse effects to California Ridgway's rails are realized and were not analyzed herein, reinitiation is required.

Effects to Recovery

Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to California Ridgway's rails in order to gain an increase in long-term habitat benefits, thereby assisting in the recovery of this species. Therefore, we conclude that the PA will not negatively affect, and may contribute to, recovery of the California Ridgway's rail.

e. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect California Ridgway's rail. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the California Ridgway's rail.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the California Ridgway's rail.

Reproduction

As Chipps Island Tidal Habitat Restoration Project is the last restoration action to tier from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp it will be consistent with the conservation measures identified in that BiOp which include surveys and buffers minimizing effects to nesting rails. Therefore, the PA is not expected to negatively affect California Ridgway's rail reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

The vast majority of California Ridgway's rails are found in the San Pablo Bay and San Francisco Bay, downstream of Suisun Marsh, where water salinities are higher (CDFW 2018). Salinity influences other variables, such as vegetation and invertebrates. Some studies have found two habitat variables of importance: youthful marshes (low stem densities and little residual vegetation produced by occasional scouring) and extensive *Spartina* (cordgrass) beds (Albertson & Evens 2000; Conway *et al.* 1993). More specifically, Zedler (2003) found that *Spartina foliosa* height and density characteristics were the most important habitat variables for predicting California Ridgway's rail habitat suitability (CDFW 2018). Suisun Marsh is generally too fresh to support *Spartina foliosa*, which may also contribute to low California Ridgway's rail densities (CDFW 2018).

With implementation of the PA, low to no mortality or injury of individuals are expected to occur from tidal marsh restoration if conservation measures in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp are implemented fully and properly. As demonstrated in Table 16 of Section 3.7.9 of the BA, most of the acreage has been constructed or is under construction. The effects of construction of all of these projects have been addressed under separate consultations with the Army Corps of Engineers. One of the slated projects (Chipps Island) has not yet been permitted, but consultation has been initiated by the Corps on this project. Restoration actions would contribute to the recovery of California Ridgway's rail by creating more suitable habitat for California Ridgway's rails. Therefore, the PA is not expected to reduce the number of California Ridgway's rails.

Distribution

The number of California Ridgway's rails affected by restoration actions will be relatively low in relation to the species' population numbers range wide. Although there is the potential to harm or disturb individuals in a way that may result in altered normal behavior, it is still expected that these activities will not cause substantial disturbance to California Ridgway's rails. Therefore, we do not expect the PA to reduce the species' distribution relative to its range-wide condition.

Conclusion

After reviewing the current status of California Ridgway's rail, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- The number of California Ridgway's rails likely to be affected by the PA will be low relative to the number of California Ridgway's rails range wide.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the California Ridgway's rail long-term.

g. References

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8. Delta Smelt

a. Status of the Species and Critical Habitat

The Action Area for this consultation encompasses the entire range of delta smelt including all of the designated critical habitat for this species. Therefore, this section also constitutes the *Status of the Species within the Action Area* and *Status of the Critical Habitat Within the Action Area* sections. The purpose of discussing the status of the species and critical habitat is to present the appropriate information on the species' life history, its habitat and distribution, and other data on factors necessary to its survival and recovery, which provide important background necessary for analyzing the effects of the PA on delta smelt.

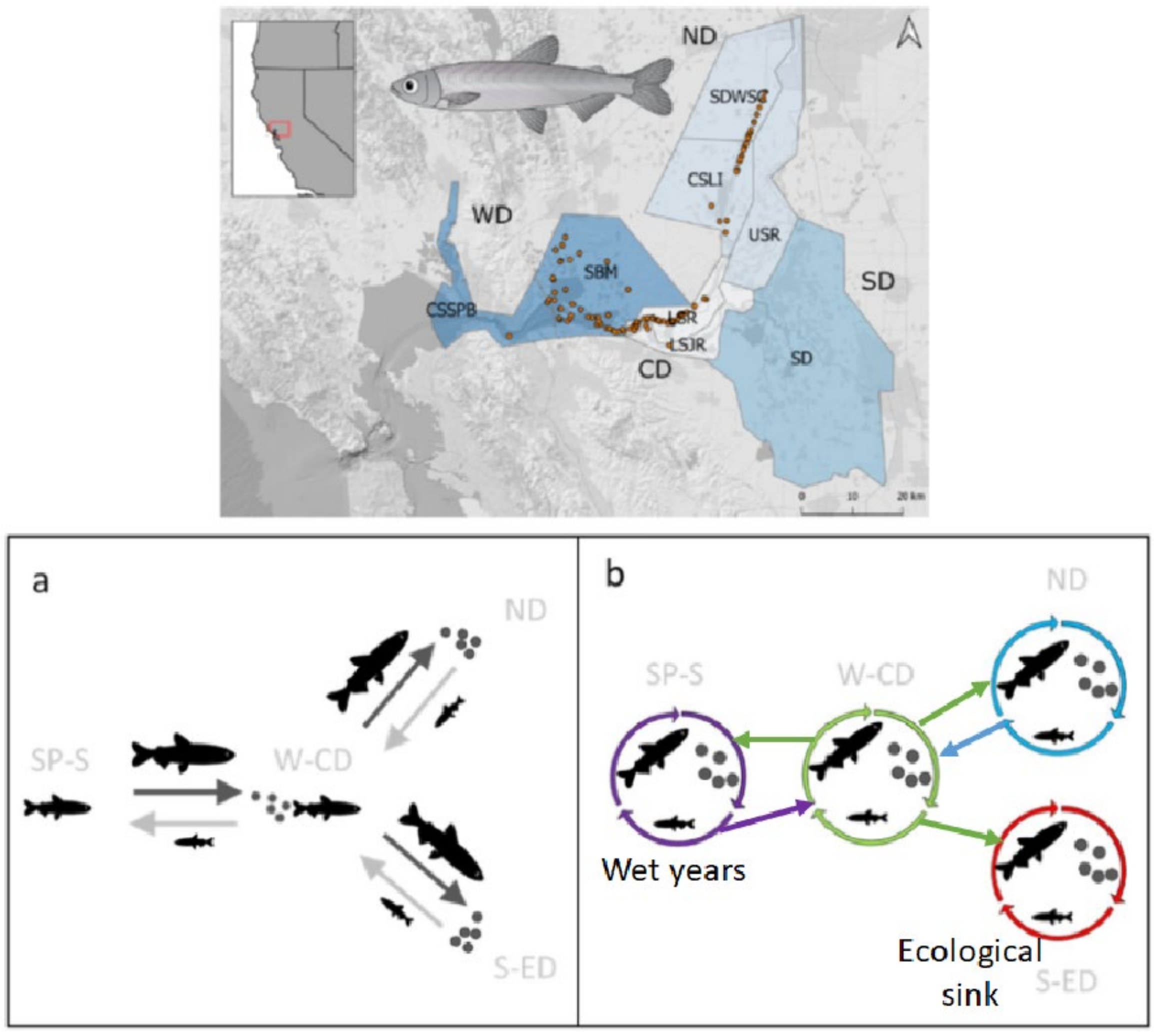
The Service proposed to list the delta smelt (*Hypomesus transpacificus*) as threatened with proposed critical habitat on October 3, 1991 (Service 1991). The Service listed the delta smelt as threatened on March 5, 1993 (Service 1993) and designated critical habitat for the species on December 19, 1994 (Service 1994). The delta smelt was one of eight fish species addressed in the *Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes* (Service

1996). A 5-year status review of the delta smelt was completed on March 31, 2004 (Service 2004). The review concluded that delta smelt remained a threatened species.

A subsequent 5-year status review recommended uplisting delta smelt from threatened to endangered (Service 2010a). A finding on a petition to reclassify the delta smelt as an endangered species was completed on April 7, 2010 (Service 2010b). After reviewing all available scientific and commercial information, the Service determined that reclassifying the delta smelt from a threatened to an endangered species was warranted but precluded by higher priority listing actions (Service 2010c). The Service reviews the status and uplisting recommendation for delta smelt during its Candidate Notice of Review (CNOR) process. Each year it has been published, the CNOR has recommended uplisting from threatened to endangered. Electronic copies of these documents are available at: https://ecos.fws.gov/ecp/species/321

The delta smelt is a small, predominantly annual fish of the family Osmeridae. The life history of the delta smelt is well-studied and has been summarized numerous times over the years (Moyle *et al.* 1992, entire, Bennett 2005, entire, Baxter *et al*. 2015, entire; Moyle *et al*. 2016; 2018, entire). The historical life cycle is shown conceptually in Figure 8-1. Historically, the basic life cycle involved a pre-spawning 'migration' in the winter, spawning and larval emergence in the spring, and juvenile fish rearing in the summer and fall. There was a debate for a while about whether or not the fish moved enough in the winter to call it a migration which is what is depicted in Figure 8-1 as two putative life history strategies. The evaluation of delta smelt otolith (earbones) microchemistry determined that some fish did, and some did not. The eggs are broadcast spawned onto substrates that are coarse enough to prevent them from being smothered (probably sand or small gravel) and all other life stages are generally 'pelagic' and affiliated most strongly with low velocity open-water habitats.

Figure 8-1: Figure 8 1: Schematic representation of the historical delta smelt life cycle. Source Hobbs et al. 2019.



The status of delta smelt in the Action Area has changed notably since 2019 as it is now a conservation-reliant species with most individuals completing a large majority of their life cycle in captivity at UC Davis' Fish Conservation and Culture Laboratory (FCCL; Lindberg *et al*. 2013, entire). For the past several years, most of the spawning population was composed of fish raised at FCCL. The actual numbers of fish released in each of the past three winters was 55,733 in WY2022, 43,940 in WY2023, and 91,468 in WY2024 (Service unpublished). The number planned for release in WY2025 is circa 100,000. The actual number of spawning fish each year has likely been lower because some fish die before they finish maturing and start looking for opportunities to spawn. Because the delta smelt was nearly extirpated when experimental releases of captive-bred fish began in December 2021, it is unlikely that individuals without any FCCL ancestry still exist at this writing. This year's catch data do not indicate that the species' status has improved. Thus, the delta smelt now exists only as an integrated hatchery-wild population as envisioned in the Delta Smelt Supplementation Strategy (Service 2020). To be clear, under current conditions, the delta smelt would be quickly extirpated (likely within at most, a few years) if the annual re-introductions of these 'experimental release' fish were discontinued. This topic is covered further in the effects analysis for delta smelt supplementation.

Status of Critical Habitat

Legal Status

The Service designated critical habitat for the delta smelt on December 19, 1994 (Service 1994). The geographic area encompassed by the designation includes all water and all submerged lands below ordinary high water and the entire water column bounded by and contained in Suisun Bay (including the contiguous Grizzly and Honker Bays); the length of Goodyear, Suisun, Cutoff, First Mallard (Spring Branch), and Montezuma sloughs; and the existing contiguous waters contained within the legal Delta (as defined in section 12220 of the California Water Code) (Service 1994).

Conservation Role of Delta Smelt Critical Habitat

The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. Delta smelt are endemic to the Bay-Delta and the vast majority of wild-born individuals only live one year. Thus, regardless of annual hydrology, the Bay-Delta estuary must provide suitable habitat all year, every year but as detailed below, it no longer does. The primary constituent elements (PCEs) considered essential to the conservation of the delta smelt as they were characterized in 1994 are physical habitat, water, river flow, and salinity concentrations required to maintain delta smelt habitat for spawning, larval and juvenile transport, rearing, and adult migration (Service 1994). The Service recommended in its designation of critical habitat for the delta smelt that salinity in Suisun Bay should vary according to water year type, which it does (Hartman *et al.* 2024, their Fig. 5). For the months of February through June, salinity standards in support of aquatic resources were codified by the State Water Resources Control Board (SWRCB) "X2 standard" described in its water rights decision D-1641 and its current Water Quality Control Plan (WQCP).

Laboratory studies

There has been a large amount of laboratory-based research on delta smelt in the last 10-12 years facilitated by the aquaculture efforts of FCCL. Some of the research was conducted to improve aquaculture techniques while other projects were intended to better understand delta smelt's fundamental physiological capabilities. These were well-done studies and the results are robust for the conditions they reflect; however, when comparing these study results to field data in support of critical habitat PCEs, it is important to keep several things in mind: (1) all of the studies used captive-bred delta smelt that have been subject to some degree of domestication and are used to being housed in relatively small spaces, (2) in most studies delta smelt were housed only with other members of their species, (3) in most studies delta smelt were fed as much food as they would eat, (4) in most studies delta smelt were not physiologically challenged while also being exposed to contaminants in the water or their food, and (5) several of these published studies are one of a series that sequentially modified the findings of the previous paper(s) as the researchers delved more deeply into aspects of delta smelt physiology and its genetic basis. With these caveats in mind, these laboratory-based research studies have found that delta smelt could theoretically tolerate 'habitat' conditions they have not been observed to in the field (Table 8-1).

Table 8-1: Summary of Experiments on Delta Smelt

Reference	Finding	Additional caveat(s)
Hasenbein *et al*.	Turbidity has a negative effect	The prey that was fed to the

Reference	Finding	Additional caveat(s)
(2013)	on delta smelt feeding rate (authors' Fig. 1)	study fish was brine shrimp (*Artemia* spp.). These are readily visible in clear water and are not a prey available to delta smelt in the wild. The authors fit a continuous linear model to data from a categorical study design and reported a statistically significant negative effect of turbidity on feeding. It cannot be determined from the data presented whether feeding was impaired at any turbidity less than 250 NTU, a very high level that delta smelt would not experience sustained exposure to in the wild.
Komoroske *et al.* (2014)	The upper thermal tolerances of delta smelt vary by life stage and range from about 25° to 28° Celsius (authors' Fig. 2). Delta smelt can survive in oceanic salinity (34 psu, authors' p. 6 and Fig. 4)	The reported thermal tolerances are endpoints that resulted in 50 percent mortality and are akin to an LD50 in classical toxicology studies. Thus, they would be highly detrimental in the wild even in the best of environmental contexts. More than one in four of the fish ultimately died in the ocean salinity treatments. These author teams published several

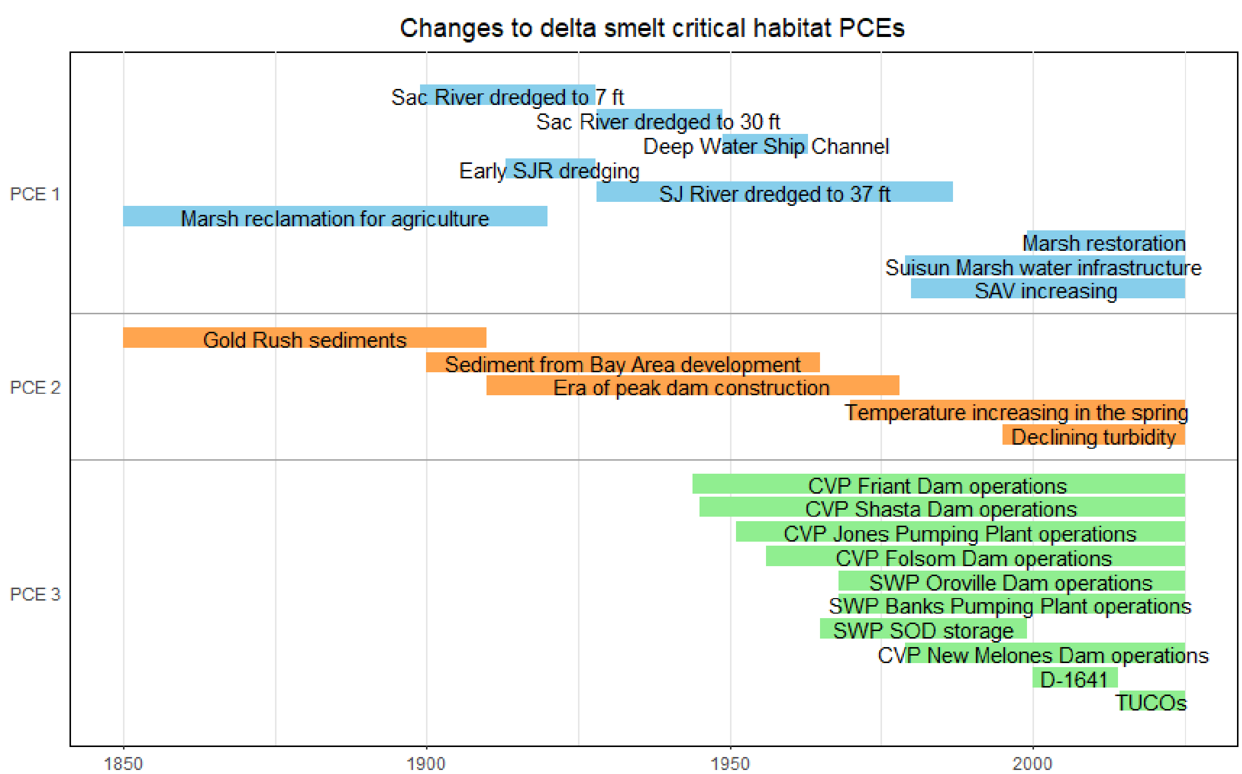
Reference	Finding	Additional caveat(s)
		follow-on papers that demonstrated the onset of stress indicators in cultured delta smelt at lower temperature and salinity than these originally reported maxima (Komoroske *et al*. 2015; 2016; 2021).
Romney *et al*. (2019)	Salinity up to 20 psu was not observed to affect the survival of unhatched delta smelt embryos (authors' Fig. 4a). However, embryos that survived long enough to hatch took longer to do so at all salinity treatments greater than or equal to 8 psu and hatching success was very low at 16 psu. Salinity was also observed to affect egg/embryo morphology in a somewhat continuous manner (authors' p. 7 and Fig. 5).	Analysis of delta smelt otolith microchemistry of n=285 fish collected from the wild in 2011 and 2012 found only 7 percent of surviving fish had been spawned in brackish water (defined very liberally as salinity more than 0.5 psu, Hobbs *et al*. 2019, p. 3). This indicates that even if delta smelt embryos can survive being spawned in brackish water, one or more subsequent life stages must experience elevated mortality.
Tigan *et al*. (2020)	This study built on a prior study of how to get delta smelt larvae to begin exogenous feeding for use in aquaculture. The earlier study had concluded turbidity and light were needed to initiate	The copepods that dominate delta smelt's natural early life diet are smaller than brine shrimp and largely translucent and thus, would be difficult to detect without turbidity in the water to 'backlight' them.

Reference	Finding	Additional caveat(s)
	feeding. This study confirmed that delta smelt larvae will not learn to feed themselves under combined low light and low turbidity, but also showed that both elevated light levels or elevated turbidity result in larvae learning to capture their own prey (authors' Fig. 1). The study also showed that under low turbidity conditions, high light levels will elevate larval growth rates which is indicative of higher feeding rates (authors' Fig. 2a). They also found that at higher light levels, turbidity did not affect growth rates (authors' Fig. 2c); however, this applied to older larvae that were being fed brine shrimp, which as discussed above are readily visible in clear water and not a naturally occurring prey (authors' p. 2888).	
Hung *et al*. (2022)	These authors developed an experimental system that could generate temperature gradients of about 0.5° to 2°	The authors' apparatus was able to generate more consistent salinity gradients than temperature gradients (their

Reference	Finding	Additional caveat(s)
	Celsius and salinity gradients of about 1 to 4 psu. They used the experimental system to increase the absolute temperature and salinity and watched to see if delta smelt responded to the gradient by moving to lower temperature or lower salinity. The authors only observed a strong behavioral preference for the cooler part of the temperature gradient at the warmest temperature tested (27°C, their Fig. 2). In contrast, the authors observed delta smelt to seek the lowest salinity water available in every trial as they increased mean salinity in the apparatus from about 0-2 up to 20-23 psu. The authors concluded as others had that "Delta Smelt can tolerate high temperatures and salinities for a short time, and that their preferences for lower temperature and salinity strengthens as these variables increase."	Figs. 2C and 3C), which might explain the more definitive fish response to salinity in the experiment.

The critical habitat baseline condition for delta smelt is that it inhabits an estuary that has been accumulating substantial change for ~ 175 years, first to its landscape and then to its freshwater flow regime (Figure 8-2). Due to species introductions and invasions, the critical habitat has a more biodiverse assemblage than what the delta smelt evolved with. Over time this presumably resulted in finer partitioning of habitat space (e.g., restrictions on when and where delta smelt can compete with other species for food) and more restrictive foraging arenas (Figure 8-2). The descriptions of the PCEs that follow reflect this altered baseline condition rather than the theoretical capabilities implied by the laboratory experiments summarized above.

Figure 8-2: Drivers of Changes to Delta Smelt Critical Habitat PCEs



Description of the Primary Constituent Elements

PCE 1: "Physical habitat" is defined as the structural or underwater 'landscape' components of habitat (Service 1994). The underwater landscape of the Bay-Delta has been substantially changed with many of the changes having occurred decades ago during reclamation of the upper estuary's historical tidal marshes and dredging of its shipping channels (Figure 8-2). The area extending from Suisun Bay and marsh up the Sacramento River into the Cache Slough Complex has been called the "North Delta Arc" and is an area that most delta smelt have been collected from during monitoring of the estuary's fish assemblages (Stompe *et al*. 2023, their Fig. 2). Several fish habitat features common in nearshore and littoral zones of many aquatic systems are listed in Figure 1-1. Most of these are not known to be relevant to delta smelt, which avoid or have limited association with submerged aquatic vegetation (SAV) and other forms of in-water structure. It has been hypothesized that delta smelt spawn in intertidal habitats because their nearest evolutionary relative, the surf smelt *Hypomesus pretiosus*, does (Bennett 2005, pp. 13-16). However, this has never been confirmed. Once the embryos hatch, the fish are believed to be generally planktonic and pelagic for the rest of their lives. However, short-term studies have shown delta smelt change their depth distribution in response to the tidal cycle moving into nearshore habitats when they do not want to be displaced downstream (e.g., Bennett and Burau 2015, their Fig. 4). Similar behaviors could facilitate their spawning 'migration' (Gross *et al*. 2021, pp. 12-13). To our knowledge, all free-swimming life stages of delta smelt predominantly use large, low velocity open-water areas, which has been recognized for a long time (Moyle *et al*. 1992, p. 67). Thus, any role of landscape attributes for the free-swimming life stages of delta smelt is likely indirect via hydrodynamic processes (e.g., current speed (Bever *et al.* 2016 p. 12), resuspension of sediment (Bennett and Burau 2015 p. 832), or in the generation of foraging microhabitats (Hammock *et al*. 2019a, pp. 861-862)).

Water diversions are a 'landscape' attribute of delta smelt habitat that is always negative because they pose an entrainment risk for nearby individuals (Figure 1-1). There are many water diversions in delta smelt's critical habitat (Herren and Kawasaki 2001). Only those that are part of CVP and SWP operations are considered in the effects analysis of this BiOp as this is the action being consulted upon. The effects of non-CVP and SWP water diversions are described in the *Cumulative Effects*.

PCE 2: “Water” is defined as water of suitable quality to support survival and reproduction (Service 1994). Certain conditions of turbidity, water temperature, and prey density dominate the characterization of suitable “water” for delta smelt. Salinity has its own PCE (number 4). Contaminant exposure can degrade this PCE even when the basic habitat components of this PCE are otherwise suitable (Hammock *et al.* 2015, their Fig. 2; Stillway *et al*. 2024, their Fig. 6). Hamilton and Murphy (2020, their Table 6) have generated summaries of historical delta smelt catch distributions relative to these subcomponents of PCE 2.

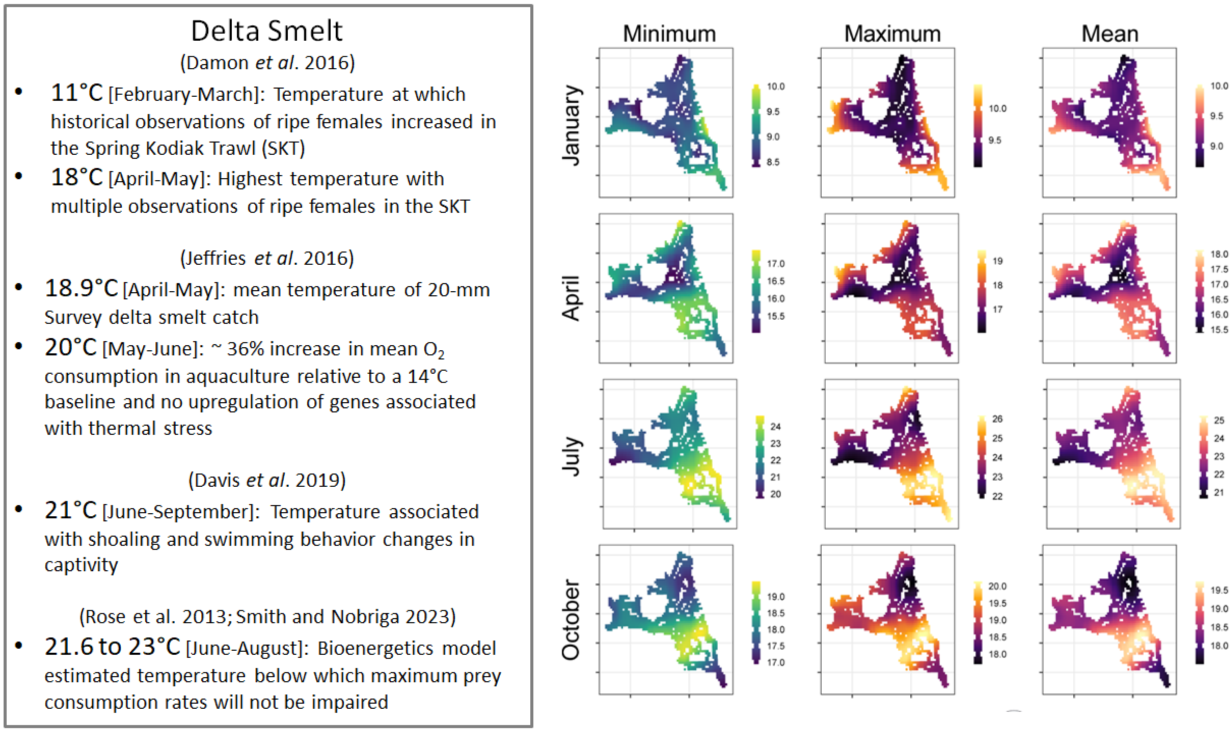
Turbidity: Turbidity is the measure of relative clarity of a liquid. It is an optical characteristic of water and is a measurement of the amount of light scattered by material suspended in the water when a light is shined through a water sample. The higher the intensity of scattered light, the higher the turbidity. Material that causes water to be turbid can include clay, silt, particulate organic matter, algae, dissolved colored organic compounds, and microscopic organisms. In the Bay-Delta, turbidity results mainly from sediment suspended in the water column and to a lesser degree phytoplankton (“suspended particulate matter”; Cloern and Jassby 2012, p. 9).

It has been repeatedly suggested that turbidity is affecting delta smelt vulnerability to trawling more than it represents an important habitat attribute (Latour 2016, his Fig. 7; Peterson and Barajas 2018, entire; Duarte and Peterson 2021, p. 16737; Hendrix *et al*. 2022, their Fig. 3). However, the association of delta smelt with turbid water has also been reported when sampling with gears other than trawls including the fish salvage facilities (Grimaldo *et al*. 2021, their Figs. 3-4) and large beach seines (Nobriga *et al*. 2005, their Fig. 3) that have little trouble capturing large numbers of fish in clear water. We do not argue that turbidity plays a role in vulnerability to capture but the totality of information available to us suggests that turbidity is an important element of delta smelt’s pelagic habitat. This is conceptually supported by research elsewhere showing that turbidity plays an important role in structuring the foraging arenas of pelagic fish communities. Small fishes detect their prey over shorter distances than the larger fishes trying to eat them (Pangle *et al*. 2012, their Fig. 1). This means that turbidity does not impair the ability of small fishes to find their planktonic prey as much as it impairs the ability of larger predators to find small prey fish. As a result, small prey fish can hide in turbid water while still being able to search for and capture prey of their own. It is via this commonly occurring food web mechanism that we believe turbidity is an essential component of delta smelt's critical habitat. This hypothesis is supported for delta smelt by evaluation of otolith microstructure that documented faster growth in turbid water (Lewis *et al*. 2021, their Fig. 5, panels F and G).

The decline of water turbidity has had a large negative effect on delta smelt critical habitat suitability. The quantity of sediment delivered to the estuary increased substantially following the era of hydraulic gold mining in the watershed in the latter 19th century (Schoellhamer 2011, his Fig. 3). It increased again during rapid regional population growth and development after World War II. Since then, the delivery of new sediment to the estuary has declined in large part due to reservoirs and widespread levee-building . In addition, summertime phytoplankton production has been greatly diminished (Cloern and Jassby 2012, their Fig. 11b). These changes have resulted in a general clearing of the estuary's waters; however, the clearing trend has been strongest in the freshwater Delta where expansive beds of SAV filter fine sediment from the water (Hestir *et al*. 2016, p. 1106; Work *et al*. 2021, p. 746). Water exports from the South Delta may also have contributed to the trend toward clearer water by removing suspended sediment in exported water. However, the contribution of exports to the total suspended sediment budget in the estuary is small (Schoellhamer *et al*. 2012, their Fig. 6).

Water temperature: We reviewed the centrality of water temperature to fish physiology, habitat suitability, and foraging arenas in the *Modeling Approach*. Several relevant temperature metrics for delta smelt are summarized in Figure 8-3. As noted in the Climate Change section of the *Modeling Approach*, air temperature is the primary driver of water temperature variation in the delta smelt critical habitat (Wagner *et al.* 2011, entire). Water temperature in the Delta can be affected by flow volumes near inflowing water sources when inflows are low (Nobriga *et al*. 2021, their Fig. 8) but the effect dissipates as the water moves seaward toward Suisun Bay (Vroom *et al*. 2017, their Fig. 11a).

Figure 8-3: Summary of Selected Delta Smelt Life History Metrics Associated with Water Temperature



Food: The predominantly open-water habitat use of delta smelt is reflected in their "food" or diet composition, which is largely made up of planktonic and epibenthic crustaceans (Moyle *et al.* 1992, their Table 1; Slater and Baxter 2014, their Tables 2 and 3; Hammock *et al*. 2017, their supplemental Figs.). Some epibenthic crustaceans (e.g., amphipods and mysids) ascend into the water column at times and are therefore available to predators foraging in open waters near the surface as delta smelt are believed to do most of the time (Moyle *et al.* 1992, p. 67). A large majority of the identifiable prey of delta smelt larvae is copepods, particularly the early life stages of copepods (Nobriga 2002, his Fig. 1; Hobbs *et al.* 2006, their Table 3; Slater and Baxter 2014, their Fig. 5). Juvenile delta smelt feeding in the summer months also have copepod-dominated diets (Slater and Baxter 2014, their Fig. 5). Older juveniles and adults continue to prey extensively on copepods but have less reliance on them and greater diet diversity (Hammock *et al*. 2019a, p. 863). All of delta smelt's major prey taxa (e.g., copepods, amphipods) are ubiquitously distributed, but which prey species are present at particular times and locations changes from early morning to mid-day, season to season, and has changed dramatically over time (Winder and Jassby 2011, their Figs. 5-9).

Contaminants: Delta smelt live in an environment that is chronically toxic to them, though the intensity of contaminant effects has been shown to vary in space and time (Hammock *et al*. 2015, their Fig. 2; Teh *et al*. 2020, their Fig. 3; Stillway *et al*. 2024, their Figs. 5 and 6). The loading of some contaminants into the habitats occupied by delta smelt can be functions of freshwater flow (e.g., Kuivila and Moon 2004, their Figs. 3-5; Stillway *et al*. 2024, their Figs. 5 and 6) so in some instances, the impacts of contaminants can be thought of as freshwater flow mechanisms. However, the impacts of others may be more strongly related to where individuals are located (Hammock *et al.* 2015, their Fig. 2), when and where they are foraging (Weston *et al*. 2019, their Fig. 9; Teh *et al*. 2020, their Fig. 3), or what salinity they occupy (Segarra *et al*. 2021, p. 12). All of these complexities affect the quantities of potentially toxic substances that get ingested over the life span of the fish, ultimately affecting their growth and reproductive potential (e.g., White *et al*. 2017, entire).

New inputs of contaminants that can contribute to accumulated toxicity and body burdens can occur at any time of year but are often associated with increased inflows to the Delta during the winter and spring (Bergamaschi *et al*. 2001, their Fig. 3; Weston *et al*. 2019, their Fig. 9). Increased gill lesion scores in delta smelt at Decker Island (Stillway *et al.* 2024, their Fig. 6C) may have been associated with the Fall X2 action and increased liver lesions in the Toe Drain and Cache Slough (Stillway *et al*. 2024, their Fig. 6F) with the Yolo Bypass food pulse experiment in 2019. Spatially, Cache Slough and Suisun Bay have been more frequently associated with biomarkers of contaminant exposure in delta smelt than Suisun Marsh, the Sacramento-San Joaquin River confluence, or the Sacramento Deepwater Ship Channel, but healthy and impaired fish have been collected from throughout the regularly occupied portion of critical habitat (Teh *et al*. 2020, their Fig. 3).

PCE 3: “River flow”. California has a Mediterranean climate with a pronounced wet and dry season that can be differentiated by the likelihood that the monthly volume of outflow from the Delta exceeds 1 billion cubic meters (~ 13,000-14,000 cfs or ~ 800 TAF per month;

Figure 8-4). We use this threshold to differentiate our use of 'wet season' and 'dry season' in this section. Prior to significant human development of surface water storage and conveyance, the wet season spanned December through June, and the dry season was July through November. The probability that monthly outflows were lower than 1 billion cubic meters was nearly zero from January through May. The substantial year to year variability of California's climate can still generate extreme flows similar to what occurred pre-development. However, median contemporary outflow is lower than pre-development outflow from December through June, and generally higher or skewed toward the higher end of the historical distributions from July through November to avoid excessive salinity intrusion into the Delta. The contemporary estuary has a shorter wet season and a longer dry season than what occurred pre-development (Figures 8-4 and 8-5). The near-term climate change assumptions that Reclamation incorporated into their CalSim3 modeling of the proposed action suggests that now and moving forward May will no longer reach the 1 billion cubic meter outflow half of the time (Figure 8-6). Thus, climate change is interacting with water use to convert May into a 'dry season' month as well.

Figure 8-4: Modeled Volumes of Delta Outflow. Sources Gross et al. 2018 and Reclamation BA.

Month	Circa 1850 probability that Delta outflow exceeded 1 billion m^3	Circa 2008 probability that Delta outflow exceeded 1 billion m^3	Approximation of present-day to anticipated circa 2037 flow regime
December			
January			
February			
March			
April			
May			
June			
July			
August			
September			
October			
November			

Figure 8-5: Conceptual Depiction of How Climate Change and Water Development Have Interacted to Change the Freshwater Flow Regime. Source: Gross et al. 2018.

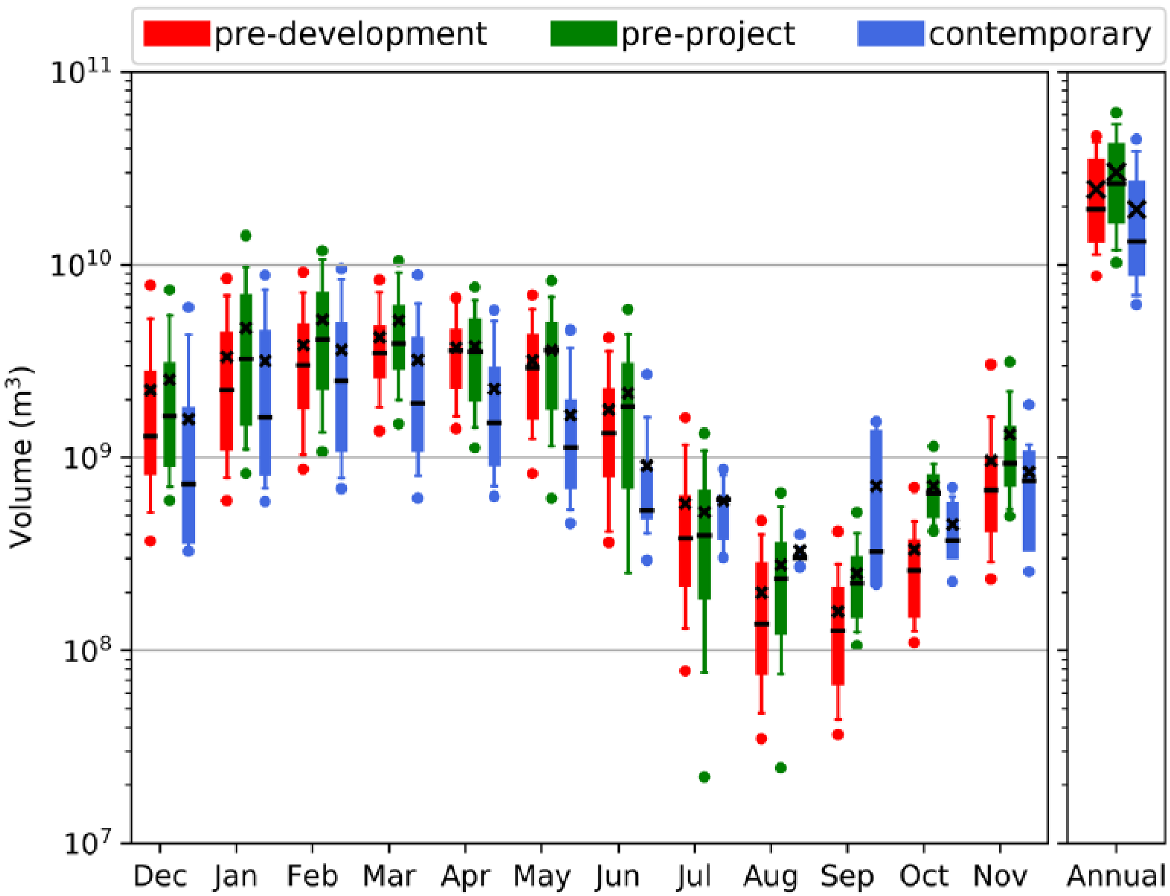
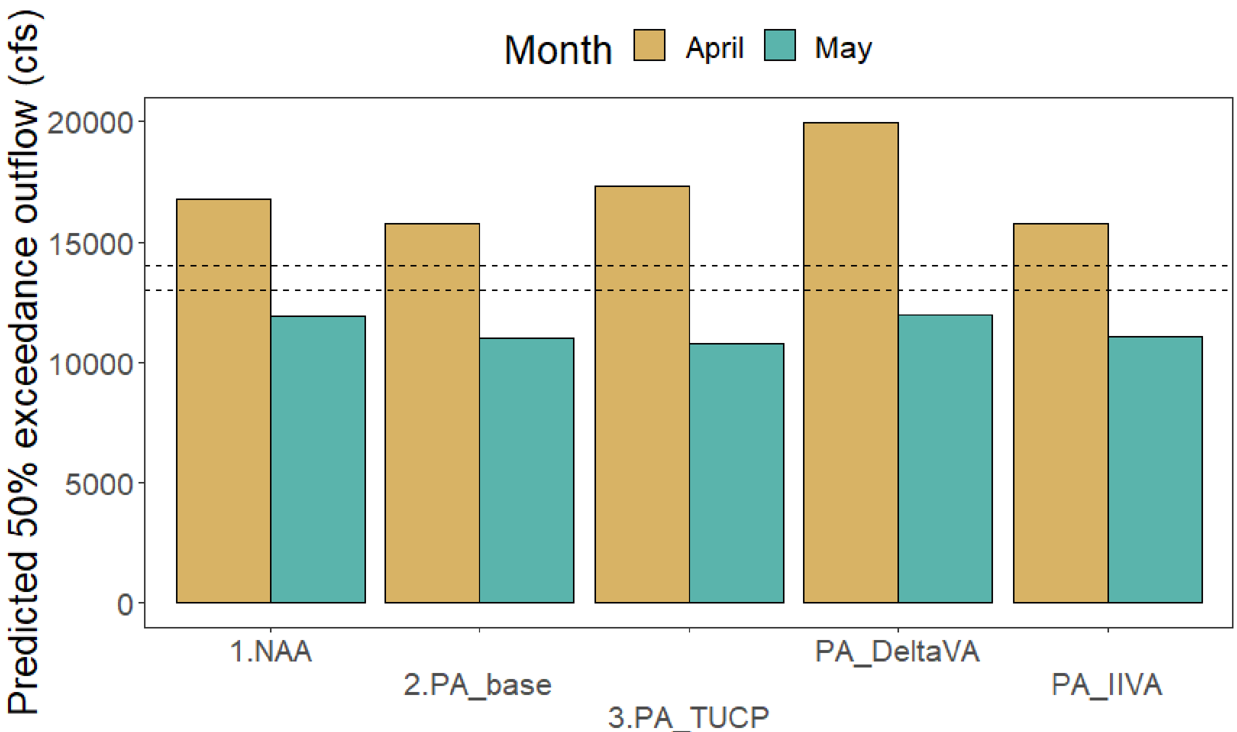


Figure 8-6: Summary of CalSim3 Delta outflow predictions for April and May



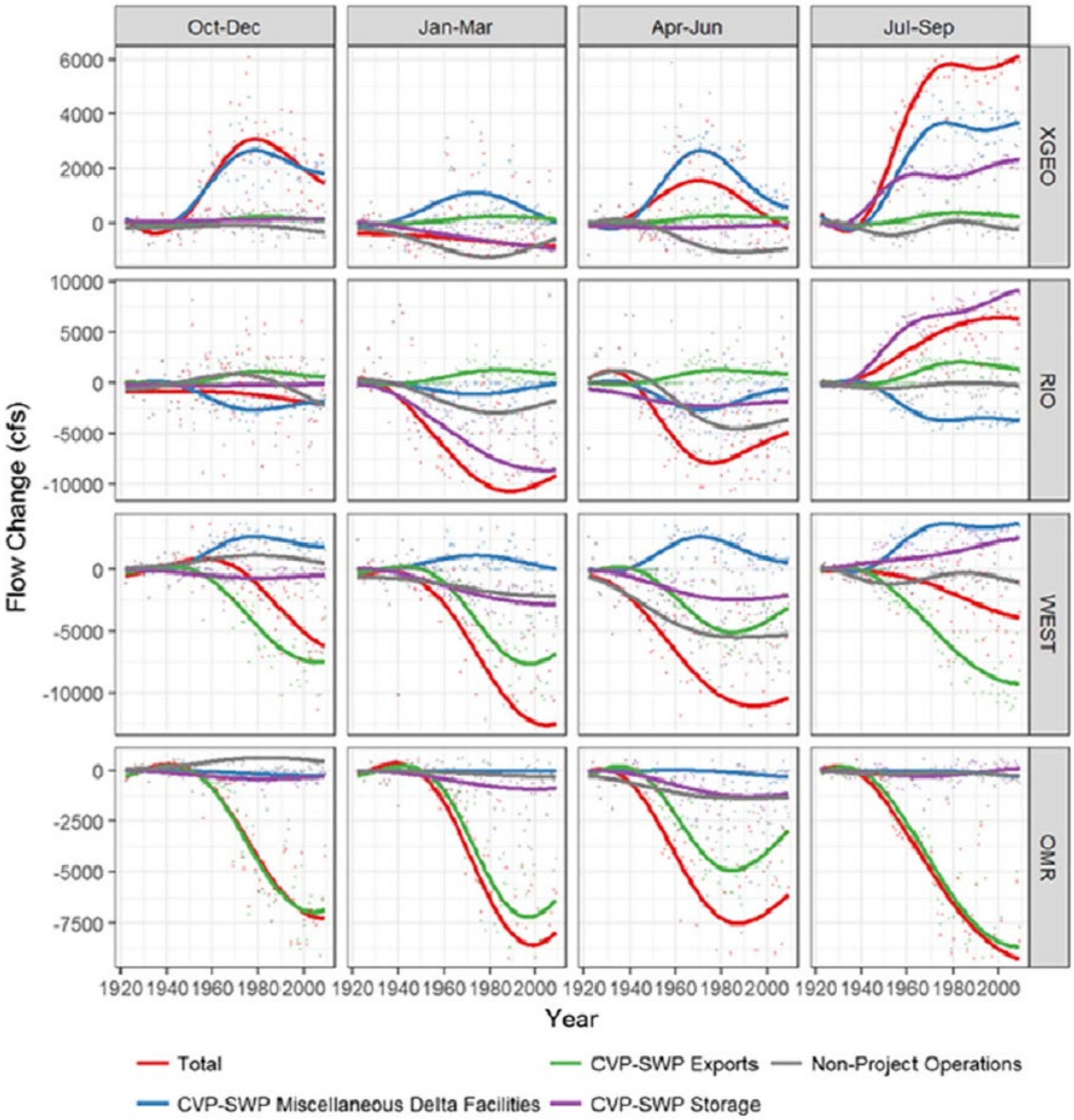
"River flow" was originally described as critical to facilitate an extended spawning migration by adult fish and the subsequent transport of offspring to rearing habitats in the low-salinity zone (Service 1994). Both of these are now understood to be affected by combinations of tidal flows and river flows (e.g., Kimmerer *et al*. 2014, entire; Bennett and Burau 2015, entire; Gross *et al*. 2021, entire). Historically, many delta smelt made a short spawning migration, but some did not (Hobbs *et al*. 2019, their Figs. 4 and 5). By a short migration we mean on the order of 50 km or less. However, for the past several years, a large majority of the spawning population has been released from captivity using a variety of techniques, but most releases have occurred near the City of Rio Vista. The fish have been observed to rapidly disperse from release sites, but these movements should not be conflated with migration. To some degree, delta smelt larvae include an element of passive drift in their suite of behaviors but the variable timing of their return to the low-salinity zone (Hobbs *et al*. 2019, their Fig. 4) and their retention well upstream of X2 until they do

(Dege and Brown 2004, their Fig. 3) suggest they have additional behaviors they can deploy to keep affiliated with desired habitat conditions.

Net water movements in the Delta have experienced strong time trends since water exports began (Hutton *et al.* 2019; Figure 8-7). In particular, cross-Delta flows (XGEO) have increased during the summer and fall, Rio Vista flows (RIO) have decreased in the winter and spring and increased in the summer, and San Joaquin River flows (WEST and OMR) have decreased year-round. The operations of the CVP and SWP were the largest contributor to these net flow changes except for Jersey Point flow (WEST) in the spring, which is also strongly influenced by in-Delta irrigation demand (Hutton *et al*. 2019, pp. 9-10). The net flow changes ultimately influence the Delta outflow, which except in the summer, has been trending downward for more than 100 years (Hutton *et al*. 2017, their Fig. 5; Reis *et al*. 2019, their Fig. 3).

The tidal and net flow of water toward the South Delta pumping plants is frequently indexed using OMR. The tidal and net flows in Old and Middle rivers influence the vulnerability of delta smelt larvae, juveniles, and adults to entrainment at the Banks and Jones facilities (Kimmerer 2011, p. 7; Grimaldo *et al.* 2009a, their Table 2; Smith *et al.* 2020, p. 796). The information cited in the previous sentence indicates that OMR is a very good indicator of larval delta smelt entrainment risk. In the summer months, juvenile delta smelt avoid the warm and clear waters of the modern South Delta which mitigates their entrainment risk (Nobriga *et al*. 2008, pp. 7-9). When maturing wild and cultured adults disperse the following winter, their advection into the South Delta can be affected by OMR flow; historically, turbidity was also an important mediator of entrainment risk (Grimaldo *et al.* 2009a, their Table 3). There is not yet enough information available to the Service for us to determine if the experimental release fish are behaving in a way that results in the same expected entrainment risk as functions of OMR and turbidity.

Figure 8-7: Changes in Delta Flow Over Time. Source: Hutton et al. 2019.



PCE 4: "Salinity". The salinity of estuary waters is determined by mixing of freshwater, which has very low salinity, and seawater, which typically has a salinity of about 33-34 psu. On average, the salinity of the upper estuary declines in a landward direction, and is most strongly influenced by Delta outflow, at least at time scales longer than a couple of weeks (Jassby *et al*. 1995, p. 275). As such, the seasonal and interannual patterns in salinity track variation in Delta outflow as do spatial locations and intensity of turbulent mixing, water column stratification and other outcomes of fresh- and brackish water mixing that help

aggregate sediment and planktonic organisms in the low-salinity zone (Mac Williams *et al*. 2015, entire). Higher freshwater flow generally lowers the salinity of delta smelt critical habitat, so salinity is at its annual minimum during the highest flows of the wet season and typically reaches an annual maximum sometime in the August through October timeframe. The "Salinity" PCE helps define delta smelt nursery habitat because nursery habitat is defined in part, by a range of salinity (Service 1994). Most delta smelt spend at least some of their life in the low-salinity zone, which has been alternately defined in the literature as 0.5 to 5 or 0.5 to 6 psu. Both definitions were derived from interpretations of where historical phyto- and zooplankton densities were elevated due to hydrodynamic retention. These definitions of the low-salinity zone salinity range are approximations that should not be expected to precisely match where delta smelt occur (Kimmerer *et al*. 2013, their Fig. 6). Most delta smelt larvae occupy freshwater or very low salinity water to ~ 2 psu. The juveniles are mostly in freshwater to a salinity of ~ 4 psu, and the older sub-adults have been found in salinity up to ~ 20 psu but were still mostly associated with freshwater and the low-salinity zone to ~ 6 psu.

b. Environmental Baseline

The Environmental Baseline describes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation in process (50 CFR 402.02). The key purpose of the Environmental Baseline is to describe the condition of the listed species and its critical habitat that exists in the Action Area in the absence of the action subject to this consultation. In this way, it provides a starting point for identifying effects of the action.

The effects of past CVP/SWP operations are also part of the Environmental Baseline (Figure 8-2). Those effects have undergone consultation and contributed to the current condition of the species and critical habitat in the Action Area. Other past, present, and ongoing impacts of human and natural factors (including proposed federal projects that have already undergone section 7 consultation) contributing to the current condition of the species and critical habitat in the Action Area are included in the Environmental Baseline for section 7 consultation purposes. A description of previous actions that have contributed to these current conditions are described in Section 2.5 of the Environmental Baseline chapter of the BA.

The following information supplements and updates the information provided in Section 2.5 of the Environmental Baseline chapter of the BA:

Agricultural Barriers installation

The Service completed a section 7 consultation on the installation of these barriers for years 2023 through 2027 on March 10, 2023 (Service File Number: 2023-0004507-S7-001). The ongoing effects to hydrodynamics from the presence of the three temporary agricultural barriers was included in the LTO modeling (referred to as South Delta Temporary Barriers in *Appendix F: Modeling Section 1-1, CalSim 3, DSM2 and HEC5Q Modeling Simulations and Assumptions*). The modeling that is relied upon in the analysis in this BiOp included the following installation dates:

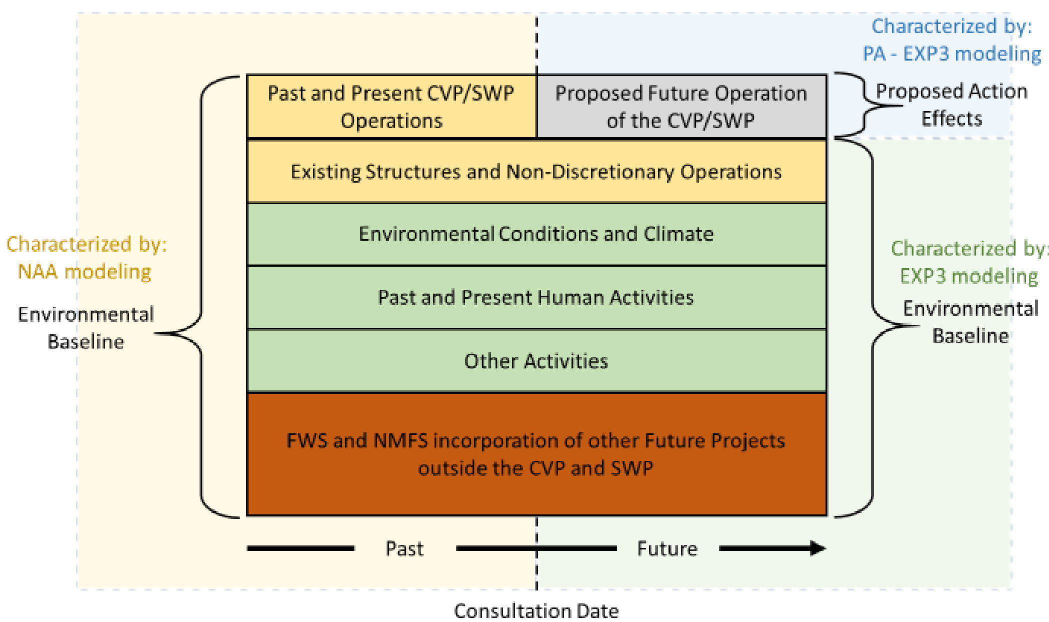
> *South Delta Temporary Barriers are operated based on San Joaquin flow conditions. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31. Head of Old River Barrier would not be installed.*

As described in the definition above, the impacts from federal agency activities or existing federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline. This component is depicted as "Existing Structures and Non-Discretionary Operations" in Figure 8-8. As depicted, these impacts have occurred in the past and will continue to occur into the future. Therefore, they form part of the foundation from which the effects of the PA are added to inform our analysis as described in our *Analytical Framework for the Jeopardy Determination* and *Analytical Framework for the Adverse Modification Determination*.

Modeling of the Environmental Baseline

The hydrologic and hydrodynamic modeling studies described above in *Consultation Approach* provide context for how the existence of the CVP and SWP facilities has affected and continues to affect the Environmental Baseline, including habitat conditions for species and critical habitat in the Action Area. Consistent with past consultations on the operations of the CVP and SWP, the dams and other existing project facilities and the long-term ecological changes that have occurred because of them are included in the Environmental Baseline.

Figure 8-8: Environmental Baseline



As described in our *Analytical Framework for the Jeopardy Determination* and *Analytical Framework for the Adverse Modification Determination* for this consultation, our analysis includes factors responsible for the range-wide condition of the delta smelt and its critical habitat. In *Appendix E - Exploratory Modeling* of the BA, Reclamation analyzed several modeling runs that depict CVP and SWP operations under different operational assumptions. The Exploratory Modeling runs provide context as to how operations have contributed to the current condition of the species and critical habitat.

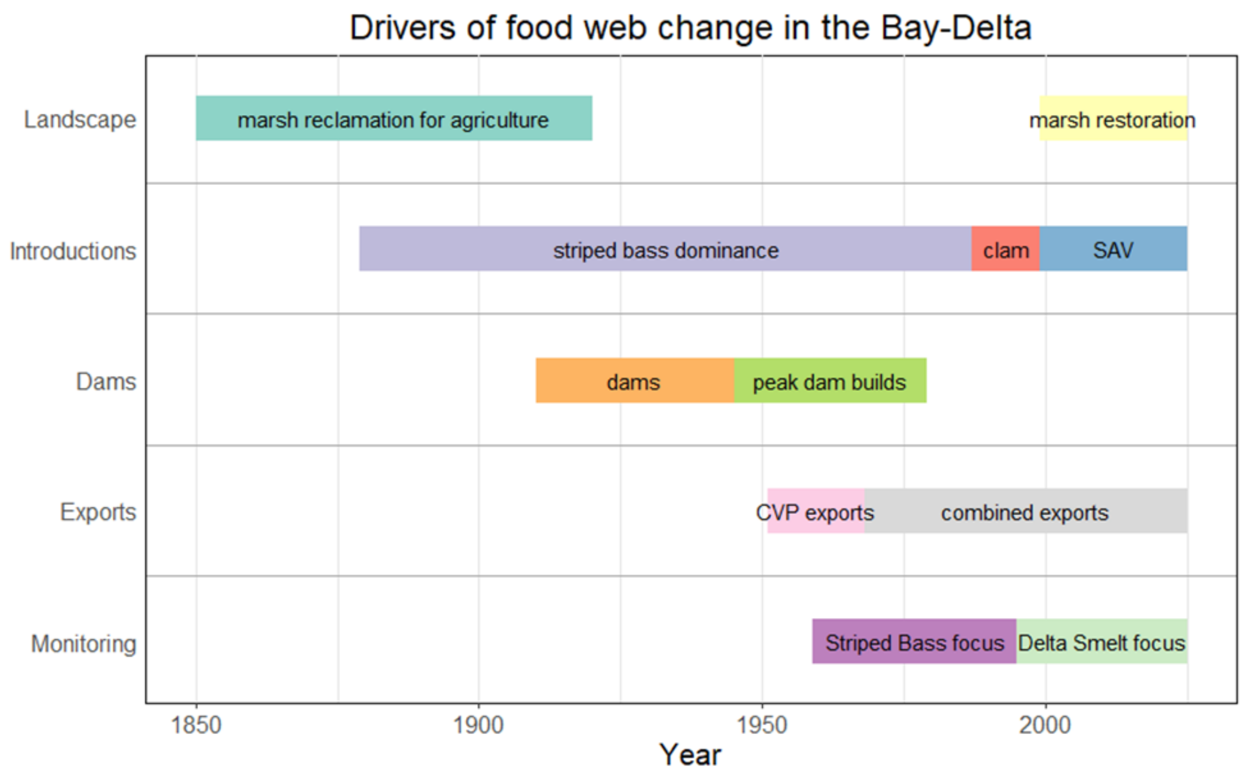
The remainder of the Environmental Baseline is made up of all other factors leading to the current condition of the species and critical habitat. This includes how past and present CVP and SWP operations have led to the current condition. These past operations include modifications from operational criteria and obligations, such as the TUCOs that have resulted from TUCPs. The totality of past factors was modeled as closely as possible by Reclamation in the NAA. These additional factors are depicted in Figure 8-8.

The Environmental Baseline does not include the effects of the action under review in the consultation. In this case, the effects of the action are those resulting from the coordinated operations of the CVP and SWP. The timeframe for the quantitative modeling that supports this 2024 consultation is 2022±15 years (based on the 2022 median climate change scenario). Therefore, the quantitative portion of our effects analysis in this BiOp is limited to this timeframe. Effects of the action not captured by the quantitative modeling will be addressed qualitatively.

Condition of the estuary food web

The food webs of the Bay-Delta estuary have been sometimes gradually, sometimes abruptly, changing for more than 170 years (Figure 8-9). Historical conversion of the estuary's wetlands to other land uses was recently estimated to have caused a 94 percent decline in the net primary production that fuels the estuary's food webs (Cloern *et al*. 2021, their Fig. 2). Most of that land conversion had occurred by about 100 years ago and only in the past 25 years or so has this long-standing loss of system-scale productivity begun to be reversed via habitat restoration (Figure 8-2). The intentional introduction of striped bass in the latter 19th century added a salinity generalist top predator into an ecosystem that did not have one. This likely affected delta smelt more than was initially realized (Nobriga and Smith 2020, pp. 3-4). Economic development of land and water in California progressed for much of the 20th century increasingly changing the estuary's average depth, and flow-salinity regimes (Figure 8-2) as well as the Delta's internal hydrodynamics (Figure 8-7). Seasonal and interannual flow or flow-salinity changes interact with the availability of other important habitat elements to influence recruitment of estuarine animals (Figure 1-1). It is probable that marsh reclamation, the striped bass and other early fish introductions, and flow regime changes during the 1940s through 1960s were as disruptive to the estuary's food webs as what is described next, but the effects went unmonitored or barely monitored and have had to be inferred from sparse information (e.g., Nobriga and Smith 2020, their Table 1) or estimated using modeling tools (e.g., Andrews *et al*. 2017, their Figs. 2 versus 3, Hammock *et al*. 2019b, their Fig. 6).

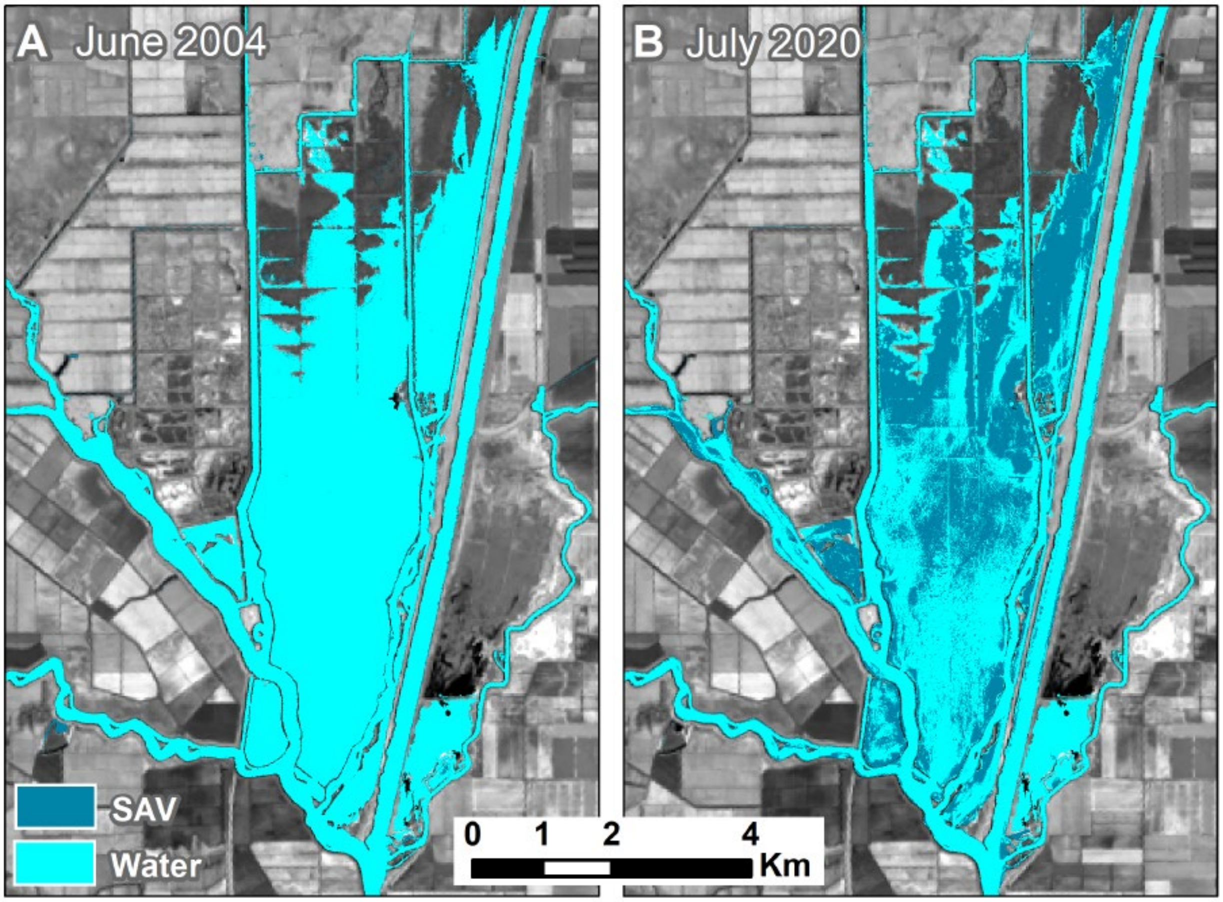
Figure 8-9: Timeline of Major Factors Contributing to Changes to Bay-Delta's Food Webs



The first major rearrangement of one of the estuary's food webs that was comprehensively monitored started nearly 40 years ago and had add-on effects that continued for at least 10 years after that (Kimmerer 2002, p. Figs. 7 and 8; Brown *et al*. 2016a, pp. 8-10). Grazing by the overbite clam *Potamocorbula amurensis,* resulted in a permanent drain on lower trophic level production resulting in rapid step-declines in the abundance of historically important food web components like diatoms, opossum shrimp *Neomysis mercedis*, and the copepod *Eurytemora carolleeae* (formerly called *E. affinis*; Kimmerer 2002, his Fig. 7; Kimmerer and Thompson 2014, entire). Because the production of these organisms was being repressed, numerous invasions of new copepod and mysid species followed resulting in wholesale rearrangement of the zooplankton assemblage. As a result, fish searching for food in the low-salinity zone were faced with a far less productive food web (Brown *et al*. 2016a, entire).

As the pelagic food web in the low-salinity zone changed in response to overbite clam grazing and new species introductions, the freshwater Delta food web was also changing, with a major shift in fish assemblages that accompanied the proliferation of SAV (Nobriga *et al.* 2005, their Fig. 3; Mahardja *et al*. 2017, their Fig. 2; Young *et al*. 2018, their Fig. 6). The SAV has encroached mainly into shallow habitats but as it has done so water clarity has increased, which can render habitat all but unusable for turbid-adapted pelagic fishes like delta smelt (Hestir *et al*. 2016, p. 1106). For instance, in fewer than 20 years, Liberty Island in the Cache Slough Complex went from a habitat suspected of supporting delta smelt spawning and definitely supporting rearing (Whitley and Bollens 2014, pp. 670-671) to an SAV-filled location that no longer supported the species (Figure 8-10). This expansion of SAV has occurred throughout the Delta's littoral habitats and generated an insular food web as it has done so. This SAV-food web can have limited exchange with the offshore pelagic food web (Brown *et al*. 2016a, pp. 16-17). To date, restoration efforts in the freshwater Delta tend to quickly be encroached on by SAV and as such may have limited ability to serve as an effective conservation strategy for fish like delta smelt and the longfin smelt DPS that are open-water foragers (Grimaldo *et al*. 2009b pp. 208-213; Christman *et al*. 2023, their Fig. 5; Clause *et al*. 2024, their Table 1). All these changes reflect the substantially altered baseline food web in which delta smelt and the longfin smelt DPS presently act as predators of zooplankton (including larval fishes) and as prey for larger piscivorous fish and birds. The top predator in the SAV-dominated Delta is largemouth bass (Conrad *et al*. 2016, entire; Huntsman *et al*. 2021, entire) and largemouth bass are willing to prey on delta smelt if given the opportunity (Ferrari *et al*. 2014, p. 85). Nonetheless, delta smelt's historical primary predator, striped bass, remains its primary predator based on DNA analysis of putative predator stomach contents (Brandl *et al*. 2021, their Table 2).

Figure 8-10: Vegatation Coverage Maps of Liberty Island from 2004 and 2020. Source Christman et al. 2022.



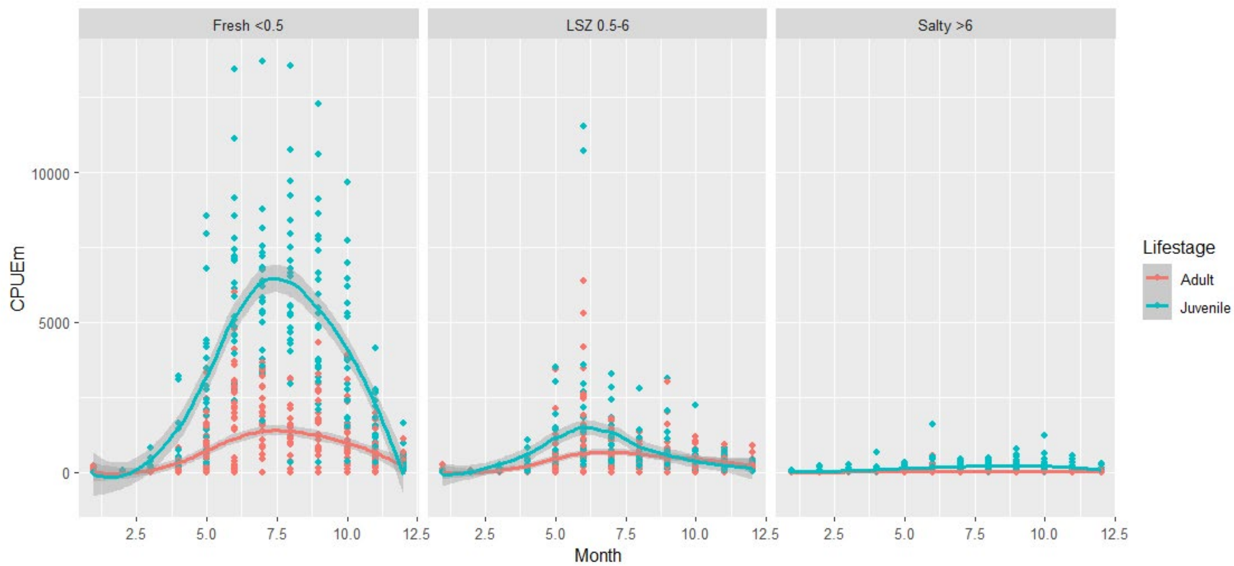
<u>Contemporary food web seasonality or 'phenology'</u>

The San Francisco Bay-Delta is a temperate set of ecosystems and as such the metabolism of its food webs is at an annual low in the winter when temperatures are coldest and an annual maximum in the summer when they are warmest. This inherent seasonality was at one time well-reflected in pelagic monitoring data (Merz *et al*. 2016, their Fig. 2). In the contemporary estuary, the food web is still at its metabolic maximum in the summer, but that is less well-reflected in pelagic monitoring metrics because overbite clam and the biotic assemblage affiliated with SAV have become biomass dominant elements of the food web and neither is well represented in samples of pelagic habitats. In San Francisco Bay, climate-mediated trophic cascades intermittently control the overbite clam (Cloern *et al*. 2007, their Fig. 3). But those controls do not extend into the upper estuary (Suisun Bay and the Delta) so what now 'succeeds' in the low-salinity zone is planktonic organisms that have some 'work-around' to avoid being grazed away (Brown *et al*. 2016a, pp. 9-11), and what 'succeeds' in the freshwater Delta is invertebrate and fish species that require, or can tap into, the food web generated by the SAV beds (Brown *et al*. 2016a, pp. 16-17).

The metabolic seasonality matters because it affects the relationships between freshwater input to the estuary and what happens in the food web. High flows tend to dilute potential prey densities for invertebrate-feeding fishes in the Delta but increase their aggregation in the low-salinity zone (Hartman *et al*. 2024, their Fig. 8). High flows also deliver greater amounts of basal food web material to the upper estuary that can be metabolized later in the year to support elevated invertebrate production (Jassby and Cloern 2000, their Figs. 5 and 7); CVP/SWP exports remove some of both the potential and realized productivity (Jassby and Cloern 2000, their Fig. 7; Hammock *et al*. 2019b, their Fig. 6). Before the overbite clam, a lot of the basal food web energy delivered by high river flows in the winter and spring became pelagic productivity in the summer; now much less of it does (Kimmerer and Thompson 2014, entire). This increases the importance of 'real-time' freshwater plankton subsidy to the low-salinity food web during the summer (Figure 8-11); without the subsidy, juvenile delta smelt's most important prey, the copepod *Pseudodiaptomus forbesi*, would not persist there (Kimmerer *et al*. 2019, p. 234). This is an example of how species invasions can change the function of an ecosystem and leave a struggling native fish dependent on an altered flow regime, which is analyzed further in *Delta Smelt Summer-Fall Habitat Action*.

Figure 8-11: Seasonality of the copepod Pseudodiaptomus forbesi (the dominant prey for delta smelt in the summer months).

Source Rosemary Hartman unpublished data.



Contemporary fish assemblages

The exchange rates in foraging arenas (Figure 1-1) can be affected by prey, but they can also be affected by co-occurring fish (Pine *et al*. 2009, entire). There is a lot of fish monitoring data available for the Bay-Delta and it is beginning to be synthesized at a high level as well (e.g., Stompe *et al*. 2020; 2023, entire). The historical niche of the delta smelt was 'zooplanktivorous forage fish', meaning a mid-trophic level predator of planktonic animals that was itself prey for larger fish and birds (Nobriga and Smith 2020, p. 5). Predation by striped bass may have been intermittently limiting delta smelt's carrying capacity for many decades (Nobriga and Smith 2020, entire), but the delta smelt also lives among an assemblage of ecologically similar fishes that varies seasonally because different species reproduce at different times of year, and spatially because the species can have abundance peaks on different parts of the estuarine salinity gradient (Feyrer *et al*. 2015, their Fig. 4). This assemblage of forage fishes has diets dominated by crustacean zooplankton, but they are all willing to supplement their diets with each other's larvae when the opportunity presents itself (e.g., Schreier *et al*. 2016, their Table 1; Hammock *et al*. 2019a, p. 863; Jungbluth *et al*. 2021, p. 1068). Thus, high biomass forage fishes with better adaptations to high salinity like northern anchovy, Pacific herring, and the longfin smelt DPS may constrain delta smelt's ability to occupy the estuary's mesohaline and marine waters and higher biomass freshwater species, which all have higher thermal tolerances, like American shad, threadfin shad, larval gobies, and Mississippi silverside may constrain delta smelt's ability to generate biomass in the fresh- and low-salinity waters it routinely occupies (expanding here on the hypothesis of Kimmerer 2006, entire). A more recent bit of anecdotal evidence for this is the sudden rise in catches of wakasagi (*Hypomesus nipponensis*) since delta smelt began trending strongly toward extirpation (IEP unpublished data). This abrupt rise of a fish that had been present for decades, but never common is consistent with what happens when a competitively dominant species disappears from an ecosystem allowing for niche expansion of the less dominant one (Pine *et al*. 2009).

c. Effects of the Action

This section analyzes components of the PA that are likely to affect delta smelt as summarized in the attached Effects Tracking Table. The action elements that are likely to affect delta smelt occur in the upper estuary (Suisun Bay/Marsh and the Delta) where the species predominantly occurs. Action components that occur in the non-tidal reaches of the Delta's watershed are not analyzed because any effects of those actions should be captured in our analysis of the various flow conditions in the Delta and Suisun Bay/Marsh. The effects analysis may differ notably in places from our 2019 biological opinion for two reasons: (1) the status of the species has changed greatly to a conservation-reliant circumstance as described in *a. Status of the Species and Critical Habitat*, and (2) the substantial scientific contributions to population dynamics that have been published since 2019. Both of these greatly improve our ability to evaluate effects in aggregate and to parse apart some mechanisms that stem from freshwater flow variation. Further, hydrologic modeling involves considerable parsing of how different opportunities and constraints on operations (climate, end users, environmental regulations) interact to affect the estuary's flow regime, which allows for more insight into baseline effects stemming from cumulative system change over the past 170 years including past water operations and their separation from effects resulting from the proposed water operations and other actions described in the PA.

Old and Middle River Management / Seasonal Operations

Subadult and adult life stages **(December-March)**

December through March were the historical peak months of maturing sub-adult and spawning ready adult salvage though it has been more than 10 years since a delta smelt was salvaged in December (Table 8-2). Historically, most delta smelt reared in the estuary's low-salinity zone in the months leading up to the first major winter storms that cued their movement back into freshwater habitats where they would later spawn (Sommer *et al.* 2011, their Fig. 3; Hobbs *et al*. 2019, their Fig. 4). The tidal and net flows in the low-salinity zone move water at much higher magnitude and velocity than in Old and Middle rivers. Estuarine fishes often use variations of tidal stream transport to maintain affiliation with desired habitat features and to relocate when motivated to do so. The available evidence indicates that delta smelt residing in the low-salinity zone historically frequented low-velocity areas associated with other desired habitat conditions (Bever *et al*. 2016, pp. 12-13). Then, they were able to move upstream against the net flow by repeatedly moving into faster offshore currents on flood tides and back into areas of slower current speeds on ebb tides (Feyrer *et al*. 2013 p. 7; Bennett and Burau 2015, their Fig. 4). It was during these tidally facilitated upstream movements that some of them ended up in the South Delta.

Table 8-2: Summary of delta smelt life history for the months of December through March. Blue shading aligns with LCME life stages (Smith et al. 2021).

Month	Spawning cohort (historical)	Progeny of spawning cohort (historical)	Contemporary observations
Dec	Life Stage: sexually immature 'subadult' LCME Life Stage: subadult 2 Habitat: Turbid open surface waters, generally at salinity < 6 psu. Occupied depths varied based on tides and local current speeds (Bennett 2005; Feyrer *et al*. 2013; Bennett and Burau 2015; Bever *et al*. 2016)	Life Stage: Not yet spawned	Experimental releases have occurred in December Salvage has not been observed in December since 2012

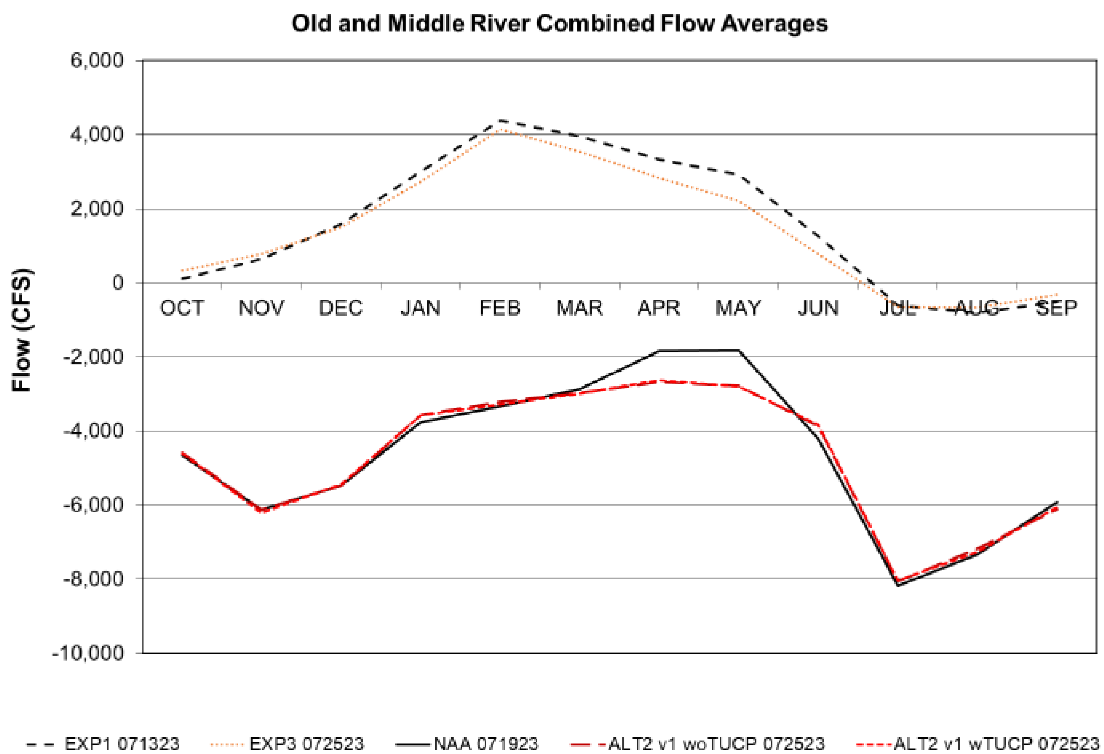
	Often observed at fish facilities (Kimmerer 2008, his Fig. 3) LCME survival covariates: OMR, South Delta Secchi depths		
Jan	Life Stage: sexually immature 'subadult' LCME Life Stage: subadult 2 Habitat: Similar to December but aggregation in Montezuma Slough, the Sac-San Joaquin confluence, and the North Delta was commonly observed in SKT (Polansky *et al*. 2018, their Figs. 2-3) Often observed at fish facilities (Kimmerer 2008, his Fig. 3) LCME survival covariates: OMR, South Delta Secchi depths	Life Stage: Few if any eggs had been spawned (Kurobe *et al*. 2022)	Experimental releases have occurred, and some fish have been observed to extrude eggs during transport and release (Service unpublished data) Salvage in January has been observed as recently as 2024
Feb	Life Stage: combination of sexually immature 'subadult' and mature adult (Kurobe *et al*. 2022, their Fig. 4) LCME Life Stage: adult 1 Habitat: Same as January Often observed at fish facilities (Kimmerer 2008, his Fig. 3) LCME survival covariates: OMR, South Delta Secchi depths and prey density	Life Stage: predominantly demersal eggs, collection of larvae was rare LCME Life Stage: not modeled Habitat: mostly but not entirely in the North Delta Arc on substrates coarse enough not to smother the eggs	Experimental releases have occurred, and some fish have been observed to extrude eggs during transport and release (Service unpublished data) Salvage in February has been observed as recently as 2024
Mar	Life Stage: mature adult; spawning began in earnest during 2011-2014 (Kurobe *et al*. 2022, their Fig. 4) LCME Life Stage: adult 2 Often observed at fish facilities (Kimmerer 2008, his Fig. 3)	Life Stage: predominantly demersal eggs, collection of larvae was rare (Bennett 2005, his Fig. 11A) LCME Life Stage: not modeled Habitat: mostly but not entirely in the North Delta Arc on	To date, no experimental releases have occurred in March Salvage in March has been observed as recently as 2023

	LCME survival covariates: OMR, South Delta Secchi depths and prey density	substrates coarse enough not to smother the eggs	

The entrainment of delta smelt during water exports is defined by the movement of a fraction of the population into the South Delta, where those individuals have little chance of successfully contributing to a subsequent generation. From December-March, the principal effect of operating Banks (SWP) and Jones (CVP) pumping plants is changes to the rates at which subadult and adult delta smelt are entrained into the channels of the southern Delta, and from there, into Clifton Court Forebay and the Skinner Fish Facility (SWP) or the Tracy Fish Collection Facility (CVP). Some delta smelt are intercepted ("salvaged") at these fish facilities but many are not. Both fish facilities use louver systems designed to guide entrained fish into holding tanks so they can be separated from water headed toward the pumping plants. The fish that are separated this way are placed into trucks and returned to the Delta, which is what the term 'salvage' refers to. However, the behavioral guidance provided by the louvers is inefficient for small species like delta smelt so many individuals pass through and continue toward the pumping plants. Fish sampled from the holding tanks in the fish facilities provide the most concrete evidence of entrainment, but a lot of entrainment goes unobserved (Castillo *et al*. 2012, their Fig. 7; Smith 2019, p. 11). For instance, Smith (2019, his Table 3) estimated that 53 to 142,488 adult delta smelt were entrained per year from water year 1994 through 2016 with a peak from 2000 through 2004 (his Fig. 4). During these same years, the numbers of subadult and adult delta smelt actually observed at the fish facilities ranged from 0 to 1,708 (Service unpublished data). Since water year 2016, observed salvage has ranged from 0 to 15 fish per year with 14 fish salvaged in each of 2023 and 2024 reflecting the higher numbers of delta smelt in the Delta following experimental release (see *Delta Smelt Supplementation*).

Further, limited experimental evidence suggests that most entrained delta smelt never reach the fish facilities because they are presumably eaten by predators in the channels of the South Delta or in front of the facilities. These putative predation rates are especially high in Clifton Court Forebay (Castillo *et al*. 2012, pp. 14-15). Fish that avoid predation but are not guided into the fish facilities die at some point during the pumping, storage, and conveyance of exported water. Thus, the Service considers the loss of fish reaching Old and Middle rivers to be essentially 100 percent due to the combination of the projects' persistent hydrodynamic influence on these channels, the high likelihood of predation, and the limited efficacy of salvage (Kimmerer and Nobriga 2008 their Fig. 7; Hutton *et al*. 2019, their Fig. 7; Korman *et al*. 2021, their Table 1). The use of OMR management is an effective way to minimize the entrainment of subadult and adult delta smelt into Old and Middle rivers and other parts of the South Delta [Figure 8-12].

Figure 8-12: Modeled Monthly Average OMR flows Anticipated for Alternatives



The ability of sub-adult and adult delta smelt to resist being moved seaward by much larger net flows than those that occur in Old and Middle rivers naturally leads to the question 'why do smaller net negative flows in the OMR corridor affect entrainment?' Much of the observed entrainment of adult delta smelt was historically associated with the "first flush", a term used as shorthand for winter storms that elevate river inflows and bring turbid water into the Delta (Grimaldo *et al*. 2009a, p. 1258; Grimaldo *et al*. 2021, p. 3; BA

Section 3.7.4.2). Most of this turbidity is delivered from the Sacramento River and Yolo Bypass (Schoellhamer *et al*. 2012, their Fig. 6). In general, the more negative OMR flow is, the more Sacramento River water is backfilling into the South Delta to replace water being exported and the faster that process is occurring. If the Sacramento River water is turbid and being moved across the Delta quickly, then the turbidity can also be transported into the South Delta (BA Appendix I, Section 6.1). The best available information suggests it was this bridge of turbidity from the Sacramento River that often provided a habitat corridor and facilitated the movement of adult delta smelt in the net flow direction of Old and Middle rivers, as they used the flood tide cycles to move further inland. Less frequently, high turbidity inflows from the San Joaquin River may have been a second mechanism that could cue fish to move into the South Delta. Either way, the more turbid the water, the more likely subadult and adult delta smelt were observed at the fish salvage facilities (Grimaldo *et al*. 2009a, their Table 3; Grimaldo *et al*. 2021, their Table 4). This historical salvage pattern may have resulted from both a habitat-use mechanism (turbidity and flow) and a predation rate mechanism (higher odds of being eaten when turbidity was lower; Korman *et al*. 2021, p. 19).

There is robust statistical evidence that entrainment was a major source of subadult and adult delta smelt mortality from December through March of 1995-2015 (Smith *et al*. 2021, their Fig. 2). Specifically, the odds were higher than not that entrainment accounted for more than 30 percent of total subadult or adult mortality in at least one month between December and March in water years 1995-2003, 2005, 2007-2009, 2012 and 2015, but it was also apparent that on average throughout recent years, OMR management helped lower the fraction of total mortality caused by entrainment (Smith *et al*. 2021, p. 1015). There is also robust evidence for the population-dynamic effect of entrainment and OMR management being modulated by regional turbidity (Smith *et al.* 2021, their Fig. 3). Thus, the inclusion of an OMR management strategy in the BA generally conforms to current best available information by combining limits on how negative net OMR flow can be with turbidity triggers.

From the onset of a "first flush" through a temperature-driven offramp date that will typically be reached in February or March (i.e. when the three-day continuous average water temperatures at Jersey Point or Rio Vista reach 53.6ºF (12ºC), the PA generally limits the 14-day Old and Middle River Index (OMRI) to no more negative than -5,000 cfs (BA Section 3.7.4), though there is a suite of conditions listed in which 'storm flex operations' may allow the 14-day average OMRI to reach -6,250 cfs under certain criteria (BA Section 3.7.4.6). The PA also includes a 'first flush action' with a conditions-based start date that can onramp between December 1 and the last day of February. The first flush action would lower OMRI to a 14-day running average of -2,000 cfs for 14 days (BA Section 3.7.4.2). Even if "first flush" conditions do not materialize by January 1, the 14-day average OMRI will automatically be limited to –5,000 cfs. The first flush action can be followed by additional turbidity-mediated OMR flow actions that may constrain the 14-day OMRI to no more negative than -3,500 cfs for a few additional days but it is also proposed to revert back to the 14-day average OMRI of –5,000 cfs when Vernalis inflow equals or exceeds a 'high flow offramp' of 10,000 cfs (BA Section 3.7.4.4). The -5,000 cfs limit would control until flow at Vernalis drops below 8,000 cfs.

These proposed operations will not eliminate subadult and adult delta smelt entrainment, but they should help to keep it at levels similar to what has occurred since 2009 when OMR management first came into full effect. The LCME proportional entrainment point estimates and interquartile ranges for the NAA and two most divergent versions of the PA are shown in Table 8-3. The sub-adult and adult point estimates range from 0.09 up to 0.16 per month, i.e., monthly losses of about 9 to 16 percent of the population. The point estimates differ by 0 to 2 percent across alternatives, a range that is small compared to the uncertainty in the estimates, which across months and alternatives suggests proportional entrainment could be as low as 4 percent or as high as 30 to 31 percent.

Table 8-3: Estimated Proportion of the Delta Smelt Population Mortality to Entrainment

Modeled life stage	Month	No Action	Alt2 with TUCP	Alt2 with full HRL and no TUCP
Sub-adult 2	Dec-Jan	0.09 (0.04 – 0.17)	0.09 (0.04 – 0.17)	0.09 (0.04 – 0.17)
Adult 1	Feb	0.11 (0.06 – 0.21)	0.12 (0.06 – 0.22)	0.11 (0.06 – 0.22)

Adult 2	March	0.16 (0.08 – 0.30)	0.16 (0.08 – 0.31)	0.14 (0.07 – 0.26)
Post-larval 1	April-May	0.08 (0.04 – 0.15)	0.10 (0.05 – 0.18)	0.08 (0.05 – 0.15)
Post-larval 2	June	0.01 (0 – 0.01)	0.01 (0 – 0.01)	0.01 (0 – 0.01)

It is unknown whether the captive-bred fish that now dominate the adult spawning stock behave the same way that the historical population did. The captive-bred fish have mostly been released in the winter into the Sacramento River near the City of Rio Vista, but occasionally other locations have been used. They are all tagged so they can be recognized when recaptured. Individuals have been recaptured everywhere that wild delta smelt historically were observed in the winter, including in the fish salvage facilities. The 'natural' mortality rates of the released fish, due to sources other than entrainment and sampling are notably higher than had been estimated for the historical wild population using LCME (Service unpublished data). Additional sources of mortality that released fish experience, but wild delta smelt do not, include transport from the hatchery, release of naive fish into habitats with predators, and the environmental conditions into which fish are released. If natural mortality increases more fish die before having the opportunity to be entrained, resulting in a smaller fraction entrained. As such, entrainment of subadult and adult delta smelt may have a smaller population effect than it did on the historical wild population from 2009 through 2021.

Larval and juvenile life stages **(April – June)**

April through June were the historical peak months of age-0 delta smelt salvage though it has been almost 10 years since a delta smelt was salvaged in May and over 10 years since one was seen in June (Table 8-4). The proportional entrainment of post-larval delta smelt in April-May has been less than 20 percent (with high confidence) since 2004 and essentially zero in June since then (Smith *et al*. 2021, their Fig. 2). This is at least partly due to the increasing water clarity in the Delta discussed in *Status of Critical Habitat*. Note that "post-larval" is a term Smith *et al*. (2020, p. 792) applied to late larval stage and early juvenile stage fish ranging in size from 20 to 45 mm in length. Since the onset of OMR management, Smith *et al*. (2021, their Fig. 2) estimate that proportional entrainment of post-larval delta smelt has tended to stay under about 10 percent of the population.

Table 8-4: Summary of Delta Smelt Life History for the Months of March through June. Blue and green shading aligns with LCME life stage timing (Smith et al. 2021).

Month	Spawning cohort (historical)	Progeny of spawning cohort (historical)	Contemporary observations
Mar	Life Stage: mature adult; spawning began in earnest during 2002-2005 (Sommer *et al*. 2011, their Table 2) LCME Life Stage: adult 2 Often observed at fish facilities (Kimmerer 2008, his Fig. 3) LCME survival covariates: OMR, South Delta Secchi depths and prey density	Life Stage: predominantly demersal eggs, collection of larvae was rare (Bennett 2005, his Fig. 11A) LCME Life Stage: not modeled Habitat: mostly but not entirely in the North Delta Arc on substrates coarse enough not to smother the eggs	To date, no experimental releases have occurred in March Salvage in March has been observed as recently as 2023
Apr	Life Stage: mature adult; spawning continued, but relatively few fish were still alive (Kurobe *et al*. 2022, their Table 4) LCME Life Stage: not modeled Salvage declined substantially (Kimmerer 2008, his Fig. 3)	Life Stage: Inferred peak of larval emergence LCME Life Stage: post-larvae 1 (only number entrained) Habitat: predominantly turbid freshwater distribution near ~ 0-1 psu (Kimmerer *et al*. 2013, their Fig. 6) Small numbers were historically observed in salvage toward month's end (Kimmerer 2008, his Fig. 3) LCME recruitment covariates: OMR, South Delta Secchi depths	Putative offspring of experimental release fish have been captured in EDSM and at the fish facilities as recently as 2024 An adult delta smelt has not been observed in salvage in April since 2012
May	Life Stage: mature adult; spawning continued, but relatively few fish were still alive (Kurobe *et al*. 2022, their Table 4) LCME Life Stage: not modeled Salvage was seldomly observed (Kimmerer 2008, his Fig. 3)	Life Stage: larvae and post-larvae; peak historical recruitment to 20-mm Survey gear (Bennett 2005, his Fig. 11A) LCME Life Stage: post-larvae 1 Habitat: predominantly turbid freshwater distribution near ~ 0-1 psu (Kimmerer *et al*. 2013,	Salvage of age-0 delta smelt in May has not been observed since 2015 Putative offspring of experimental release fish have been captured in EDSM

		their Fig. 6) Peak historical salvage (Kimmerer 2008, his Fig. 3) LCME recruitment covariates: OMR, South Delta Secchi depths; peak of predicted proportional entrainment of post-larvae (Smith *et al*. 2021, their Fig. 2)	
Jun	Life Stage: Essentially complete end of the spawning season and cohort life though a few individuals would persist and survive to a second spawning season (Bennett 2005, his Fig. 13A; Damon *et al*. 2016, their Fig. 9)	Life Stage: post-larvae and juveniles; Larval emergence concluded and in cool years, June was peak recruitment to 20-mm Survey gear (Bennett 2005, his Fig. 11A) LCME Life Stage: post-larvae 2 Habitat: predominantly turbid freshwater distribution near ~ 0-1 psu (Kimmerer *et al*. 2013, their Fig. 6) but increasingly absent from the South Delta as water clarity increased Peak historical salvage continued (Kimmerer 2008, his Fig. 3) LCME recruitment covariates: OMR, South Delta Secchi depths	Salvage of age-0 delta smelt in June has not been observed since 2013 Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity was predicted to chronically limit foraging upstream of the Sac-San Joaquin confluence; predicted onset of thermal stress in the Delta in 2017 and 2020; Suisun Bay was food limiting in 2016 but not other years (Smith and Nobriga 2023, their Fig. 3)

The collection of age-0 (larval, 'post-larval' and juvenile life stage) delta smelt at the fish facilities is the most concrete evidence of take via entrainment; however, salvage of these life stages is even less efficient than for subadults and adults. As a result, a large majority of age-0 entrainment goes unobserved, especially early in the spring when many fish are still too small to be salvaged (Kimmerer 2008, his Fig. 6; Castillo *et al*. 2012, their Fig. 7; Smith *et al*. 2020, p. 797). Specifically, the salvage of delta smelt less than 20 mm in length is for all intents and purposes, zero (Kimmerer 2008, his Fig. 6). The entrainment loss of delta smelt larvae is not included in the estimates provided above. Kimmerer (2008, pp. 16-17) included estimates of this ‘invisible’ entrainment of larvae in his larval-juvenile proportional entrainment calculations for 1995-2006, but we are not aware of robust assessments of proportional losses of larval delta smelt post-2008. The analysis of otolith microchemistry has confirmed that most delta smelt are spawned in freshwater and that most of the surviving fish will eventually end up spending time in the low-salinity zone (Hobbs *et al*. 2019, their Figs. 4-5). This reinforces earlier assertions that young delta smelt were using river and tidal currents to move from the Delta into Suisun Bay or under lower flow conditions to the confluence region of the Sacramento and San Joaquin rivers from about Decker Island to Chipps Island (e.g., Moyle *et al*. 1992, their Fig. 4). Because these age-0 fish have some element of ‘drift’ in their early life history, the influence of net flows in the South Delta on entrainment risk can be approximated well using particle tracking modeling (Kimmerer 2008, his Fig. 16) and that approach was applied in newer evaluations of age-0 delta smelt entrainment, but with the recognition that including turbidity improved the predictions (Smith *et al*. 2020, their Table A3; Smith *et al*. 2021, their Fig. 3). The Service considers the loss of larval and juvenile delta smelt reaching Old and Middle rivers to often approach 100 percent due to the projects’ persistent hydrodynamic influence on these channels (Kimmerer and Nobriga 2008 their Fig. 7; Hutton *et al*. 2019, their Fig. 7; Smith *et al*. 2020, their Table A3). Thus, we support the proposed use of OMR management to minimize the entrainment of age-0 delta smelt into the South Delta.

The PA for age-0 delta smelt continues to generally limit the 14-day OMRI to no more negative than -5,000 cfs until seasonal offramps for OMR management are all reached (BA Section 3.7.4.7). Under a particular suite of conditions listed in ‘storm flex operations’ the 14-day average OMRI can reach -6,250 cfs (BA Section 3.4.7.6). The -5,000 cfs OMRI baseline operation would generally continue so long as Secchi disk depths measured in fish surveys average more than 1 meter (BA Section 3.7.4.5). Secchi disk depths averaging less than 1 meter are indicative of turbid water conditions in the South Delta that are associated with higher entrainment risk (Smith *et al*. 2021, their Fig. 3). The default operation during these more turbid conditions is a 14-day OMRI no more negative than -3,500 cfs with one exception; the Projects propose to operate to a 14-day OMRI no more negative than -5,000 cfs even when Secchi disk depths are less than 1 meter during times when river inflows into the Delta are very high because the expectation is that delta smelt larvae will be transported seaward under those conditions (except for those individuals that have already been entrained into the South Delta). These proposed 'high flow offramps' would be in effect whenever Sacramento River net flow at Rio Vista exceeds 55,000 cfs until it falls below 40,000 cfs or San Joaquin River flow at Vernalis exceeds 8,000 cfs until it falls below 5,000 cfs. The proposed Adaptive Management Program also includes an action to determine whether the South Delta turbidity conditions based on Secchi disk depths can be replaced using turbidity gauge data. The Service would need to agree to any proposed change but if a suitable conversion from Secchi depths to turbidity can be developed that does not increase anticipated effects over what was analyzed in this BiOp, then switching to turbidity gauges should be acceptable.

These proposed operations will not eliminate larval and juvenile delta smelt entrainment, but they should help limit it to levels similar to those occurring since 2009 when OMR management rules first came into full effect. The LCME proportional entrainment point estimates and interquartile ranges for the NAA and two most divergent versions of the PA are shown in Table 8-3. The point estimates for post-larvae range from 0.08 up to 0.10 in April-May, i.e., losses across these two months of about 8 to 10 percent of whatever the population size is at that time. The point estimates differ by 0 to 2 percent across alternatives, a range that is small compared to the uncertainty in the estimates, which across months and alternatives suggests proportional entrainment could be as low as 4 percent or as high as 18 percent. In contrast, predicted loss in June is essentially zero with the upper end of the interquartile range only reaching 1 percent and does not vary among alternatives.

Quantitative population-dynamic effects of entrainment

In general terms, the recruitment of new delta smelt generations was linked in the statistical life cycle models to entrainment losses, the prey density nominally available to adult spawners, and water temperature during the spring spawning season. The survival of the young fish through the juvenile life stage was associated with the amount of Delta outflow from June-August and other habitat conditions in the fall months (or the fall was not even included in the lowest AIC models). Lastly, the survival of sub-adults was linked to winter entrainment and an index of putative predation pressure by striped bass. All of these factors were included in the modeling described below as covariates except that entrainment of sub-adults, adults, and post-larvae was explicitly modeled in LCME as discussed above.

The results Reclamation presented in BA *Appendix F, Attachment F, Table 2* have several similarities and differences to what was reported by Polansky *et al*. (2021, p. 7, their supplemental information Table C.4). We have provided an explicit comparison below (Table 8-5). The similarities likely reflect covariates whose direction of effect is robust to alternative model configurations and assumptions (e.g., Polansky *et al*. 2023, their Fig. 3). Differences were observed in different formulations of the same model as well as when comparing across them. This presumably shows that there are limits to interpreting correlations.

All model variations summarized in Table 8-5 suggest that operations of the CVP and SWP had some direct influence on delta smelt population dynamics during 1995-2015, but they do not always agree on when or at what magnitude. Even where the models agree, they frequently disagree on how supportable the covariate linkage was. The covariate influences on delta smelt survival that were supported in both versions of MDR and LCMG were influences of X2 (location in the Bay-Delta where the tidally averaged bottom salinity is 2 parts per thousand) or Delta outflow on survival in the summer, water temperature and water transparency on survival in the fall, and an influence of water transparency in the South Delta on survival through the winter. The influence of OMR on survival in the winter was supported in three of four model variations. The general agreement among models for an influence of OMR and South Delta Secchi depth in the winter provides inferential support for the management of entrainment using OMR and turbidity, described in the PA (BA Section 3.7.4). The influence of summer and fall habitat conditions is explored further in our analysis of the *Delta Smelt Summer-Fall Habitat Action*.

Table 8-5: Summary of Life Cycle Modeling Results

Modeled vital rate	Covariate averaging period	Model version	Supported covariates
Recruitment of new generations (number of post-larvae produced per adult)	March-May	LCMG 1	Temperature, *Prior Fall X2*, Adult Prey density
		LCMG 2	Temperature
		DD MDR	*Prior Fall X2*
		DI MDR	None
Survival of fish from post-larvae to juveniles	June-August	LCMG 1	*Outflow*, Secchi depth
		LCMG 2	*Outflow*
		DD MDR	Temperature, Prey density, *X2*
		DI MDR	Temperature, Prey density, *X2*
Survival of fish from juveniles to subadults	September-November	LCMG 1	Secchi depth, Temperature
		LCMG 2	Temperature, Secchi depth
		DD MDR	Secchi depth, Temperature
		DI MDR	Secchi depth, Temperature
Survival of fish from subadults to spawning adults	December-February	LCMG 1	South Delta Secchi depth, *OMR*, Striped Bass abundance index
		LCMG 2	*OMR*, South Delta Secchi depth, and prey density for delta smelt

		DD MDR	South Delta Secchi depth
		DI MDR	South Delta Secchi depth and *OMR*

Beginning in the latter 2000s, the implementation of OMR management strategies lessened the quantitative effect of entrainment on delta smelt population dynamics (Smith *et al*. 2021, p. 1015). These authors used the LCME to predict the population-level effects of three hypothetical OMR management strategies under three different sets of environmental conditions (Smith *et al*. 2021, their Table 6). The analysis used a hypothetical 'baseline' that in simple terms represented the effects expected if mean OMR was 0 cfs in every month from December through June. This baseline covered all entrained life stages from migrating subadults through the post-larval stages of their progeny. The baseline was compared to results using a mean December-June OMR of -5,000 cfs (-142 cms in metric units) and a mean December-June OMR of -7,500 cfs (-212 cms in metric units). The simulation indicated that the population growth rate would decline by about 3 percent over three years if OMR were managed to -5,000 cfs (-142 cms in metric units) and another fraction of 1 percent if OMR were managed to -7,500 cfs (-212 cms in metric units). The magnitude of the predicted effect of entrainment was about the same in each of the three environment scenarios. This result reflects the predicted combined effect of entraining age-1 fish and their progeny, but qualitatively, it can be seen from Figure 2 in Smith *et al*. (2021) that the long-term average proportional effect of entrainment was highest in March (early and late adults), followed by February (late subadults), followed by December-January (early subadults), followed by April-May (early post-larvae), and was usually rather minimal by June (late post-larvae). This same order is reinforced in the predictions for this consultation (Table 8-3).

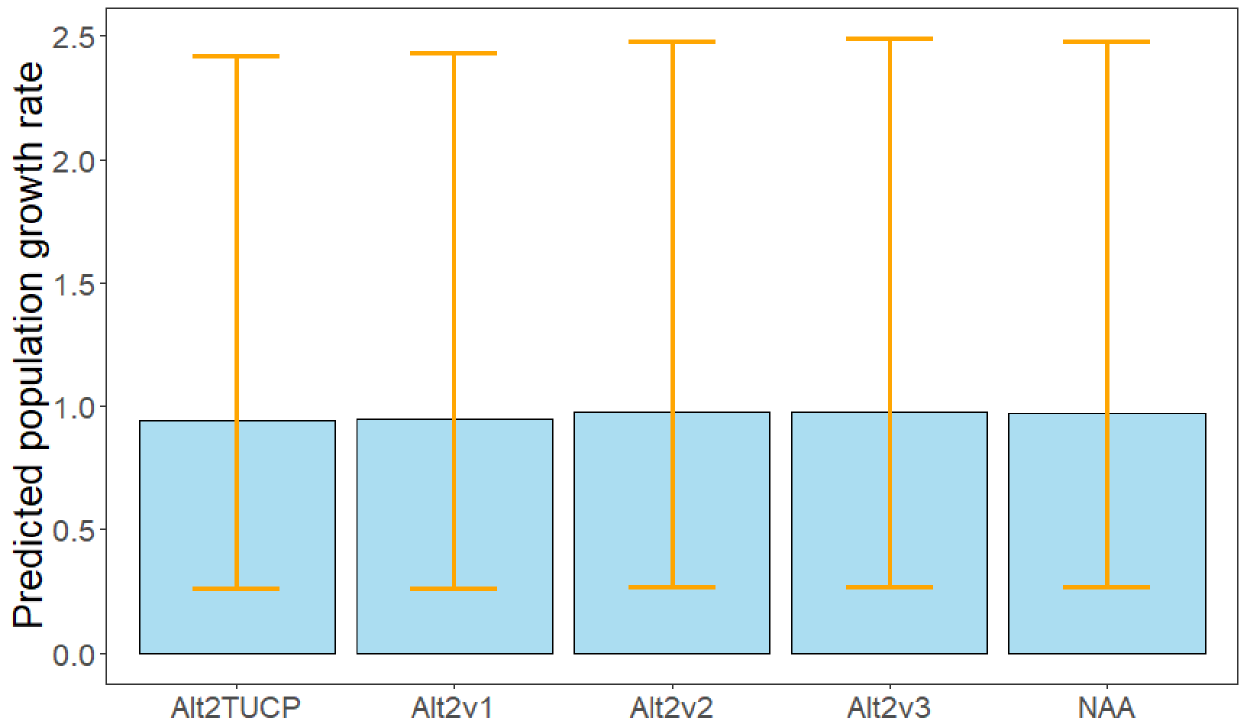
Reclamation and the Service used LCME to simultaneously evaluate several flow-related effects of the PA on predictions of delta smelt population growth rate (BA *Appendix F, Attachment X*). The CalSim 3 inputs were used in the LCME application to predict entrainment losses via OMR (December-June; Table 8-3), adult prey supply via a zooplankton sub-model that used March and April Delta outflow as a driver, and mean June through August Delta outflow as a modifier of survival from the post-larval to the juvenile life stage (Table 8-4). The Service extracted the results that were most pertinent to this consultation from Table 5 of BA *Attachment J – Longfin Smelt Outflow* and plotted them for easy visualization Figure 8-13.

The climate – meaning whether the modeled year was wet or dry – had the largest effect on the predicted population growth rate in every scenario (Table 8-6). The geometric means of the growth rates indicated that the population would generally increase in wet years under all alternatives. Likewise, the geometric means of the growth rates indicated that the population would generally decrease in dry years under every alternative – even the run of the river ("Exp1") and a second experimental scenario in which no South Delta exports occurred ("Exp 3"). The changes in geometric mean growth rate between wet and dry years were most variable in these experimental runs, substantially muted in the No Action run ("NAA") and muted further still in the four PA variants ("Alt2"). The generally more favorable population predictions for Exp3 suggest like the Kimmerer and Rose (2018) thought experiment (their Fig. 5), there would be considerable population benefit if entrainment could be eliminated, which of course is not possible. Overall, the LCME results indicate that there is no discernable difference in predicted population outcomes for any version of the PA (Alt2) or the NAA (Figure 8-13).

Table 8-6: Largest Effect on The Predicted Population Growth Rate Across Alternatives

Category	Alt1	Alt2 Without TUCP Without VA	Alt2 With TUCP Without VA	Alt2 Without TUCP Delta VA	Alt2 Without TUCP Systemwide VA	Alt3	Alt4	Empirical	NAA
1995-2015	0.72	0.95	0.94	0.98	0.98	1.20	0.94	0.96	0.97
Below Normal, Dry, or Critically Dry years	0.54	0.75	0.74	0.77	0.77	0.95	0.72	0.58	0.74
Wet and Above Normal years	0.98	1.24	1.24	1.27	1.28	1.55	1.25	1.68	1.32

Figure 8-13: Predicted Geometric Mean Population Growth Rate of Delta Smelt using LCME



Based on our analysis of the PA and its predicted effects we conclude:

- entrainment loss has remained an important effect of CVP and SWP operations in the post-2008 era of more careful OMR management, though at a lower frequency and only demonstrably so for the subadult and adult life stages (recently, January through March, though this could change based on timing of releases of fish from FCCL);

- the role of entrainment as a factor contributing to delta smelt population decline is robustly discernable only when comparing substantially different OMR values and turbidity conditions over multiple years;

- the best available modeling information we have suggests there is no discernable quantitative effect of any version of the PA on predictions of delta smelt population growth rate relative to the NAA. We expect this conclusion to be robust across any reasonably foreseeable (i.e., small) population size; and

- although entrainment of some released fish will lower the total egg supply for the next generation, the ongoing supplementation is expected to more than offset those losses.

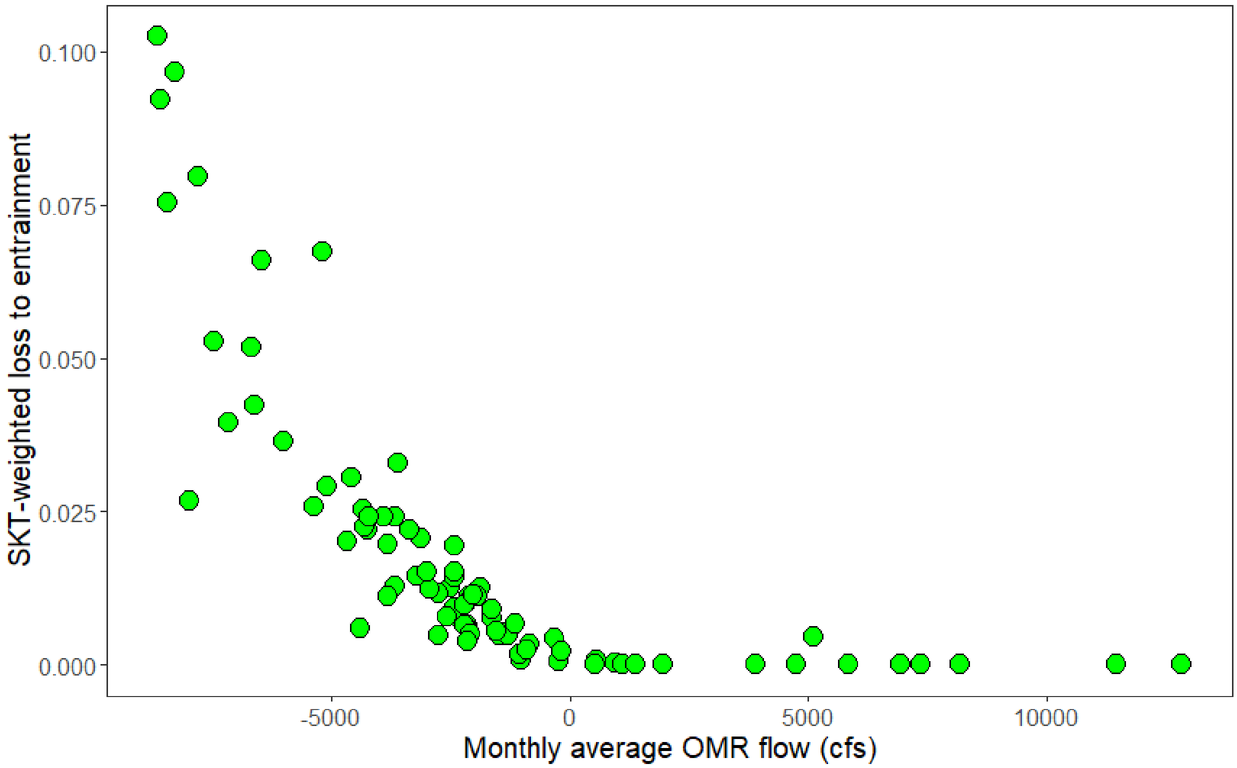
Real-time operations

The PA includes numerous specific OMR actions tailored to multiple affected species and life stages (BA *Section 3.7.4*) and it continues to indicate a need for regular meetings of the Smelt and Salmonid Monitoring Teams, though no meeting interval is specified (BA *Section 3.13.3.4.2*). Below, we review why the Service no longer thinks weekly input from the Smelt Monitoring Team is necessary.

Fish salvage data are collected and reported daily from the Skinner Fish Facility (BA *Section 3.7.8*) and Tracy Fish Collection Facility (BA *Section 3.7.7*). This availability of high frequency data led to exploration of whether quantitative models could be deployed to increase the objectivity of real-time water operations decisions about sub-adult and adult delta smelt entrainment risk. Grimaldo *et al*. (2021, pp. 3-8) applied a 'machine learning' approach called boosted regression trees (BRT) to several versions of daily delta smelt salvage data collected over 24 winter seasons (December 1 – March 31, 1993, through 2016, and subsets thereof). The BRT-based analysis of delta smelt salvage supported the continued use of OMR and turbidity as predictors; it also supported a few other precipitation and inflow variables (Grimaldo *et al*. 2021, their Table 4 and Fig. 3). At first glance, the BRT models appeared to work very well because the coefficients of determination indicated the models were explaining most of the variability in the data. The fraction of variability predicted depended on the specific data set but ranged from 0.85 to 0.94 (Grimaldo *et al*. 2021, their Table 3). Had the authors stopped there they would have mistakenly given the impression that delta smelt salvage could be predicted on a daily time step with high accuracy given a few readily available predictor variables. Instead, they picked 5 of the 24 years to remove from the model one at a time, refit a BRT without that year, and then used each 23-year model to try to predict what happened in the missing 24th year. This 'leave one out' step showed the explanatory power came from retrospectively fitting to each year's unique set of conditions and it showed the BRT models had limited utility for predicting what had happened in individual years. The fraction of variability in the missing year that the BRT models were able to predict was less than 0.1 in 8 of the 10 trials and reached a maximum of 0.2 for SWP salvage and 0.36 for CVP salvage in 2004 (Grimaldo *et al*. 2021, their Table 5). Thus, over short time scales, quantitative predictions of subadult and adult delta smelt entrainment at time scales relevant to real-time management are unreliable.

The relative entrainment risk of age-0 delta smelt can sometimes be evaluated over short time scales using the DSM2 particle tracking model (PTM), which can run at time steps as short as 15 minutes. Under low flow and export conditions however, particle fates can take (simulated) weeks to months to fully resolve (Kimmerer and Nobriga 2008, p. 10). This is because the predicted transport of particles around the DSM2's virtual Delta is dominated by net flow directions (called advective flows) rather than the back-and-forth movements caused by the modeled tidal flows (called dispersive flows) (Kimmerer and Nobriga 2008, p. 10 and their Fig. 4). As a result, high inflows or high exports are required inputs to generate rapid resolution of particle fates. Further, when PTM results were coupled with historical survey-based distribution data, time steps of 1 to 2 months were required to make robust predictions of population effects of entrainment on age-0 delta smelt (Smith *et al*. 2021, p. 1010). Using OMR alone does not yield high precision predictions because outcomes also depend on river inflows, tidal cycles, and gate operations, especially near the time that particles are released into the model environment (Figure 8-14). Nonetheless, if as an example, two runs use the same hydrology and particle release times and differ only in export levels to generate differences in OMR, the run with the lower export and by extension less negative OMR, will always predict lower particle entrainment and therefore be the more 'protective' choice.

Figure 8-14: Relationship Between OMR Flow and Predicted Fraction of the Age-0 Delta Smelt Population Entrained given a *hypothetical fixed distribution of their parents*



Based on this review of currently available information, the Service does not think it is possible to draw robust quantitative conclusions about entrainment effects to delta smelt at time scales less than about 1 to 2 months. Therefore, it seems inappropriate to ask the Smelt Monitoring Team to try to do so each week. At time scales less than a month, it is possible (and rational) to qualitatively conclude that all else equal, the least negative OMR in a set of alternatives is the one most likely to result in the lowest risk of entrainment. We reiterate a quote from Smith *et al*. (2021, p. 1021) here:

> In a population in which recruitment success rates cannot sustain the population, no additional mortality is sustainable; there is no surplus production. Given average environmental conditions, no level of predicted delta smelt entrainment mortality, including that associated with zero net OMR, led to a high probability of population growth. No additional mortality can be sustained by the population, but that does not mean that entrainment mortality of 0 will result in its recovery. Entrainment mortality cannot be

> completely eliminated because water exports must continue; thus, the question of a target level of entrainment mortality becomes a subjective policy question. How much attrition are policy-makers willing to accept?

The authors' conclusion was based on best available information and as such, as long as the PA is implemented as described, and as analyzed here, the Service no longer sees a beneficial effect in asking the Smelt Monitoring Team for weekly advice on OMR alternatives that are ultimately subjective policy decisions. The PA includes instances when SMT may be asked to convene to review information for proposed deviations from expected real-time operations for delta smelt such as when a "first flush" action may not be warranted (BA *Section 3.7.4.2*), a "storm flex" action may be warranted (BA *Section 3.7.4.6*), and for an end of the year evaluation (BA *Section 3.7.4.8*). As part of overall OMR management and governance, input from the Smelt Monitoring Team in these instances will help inform technical considerations as part of policy decisions.

<u>Barker Slough Pumping Plant (March through June)</u>

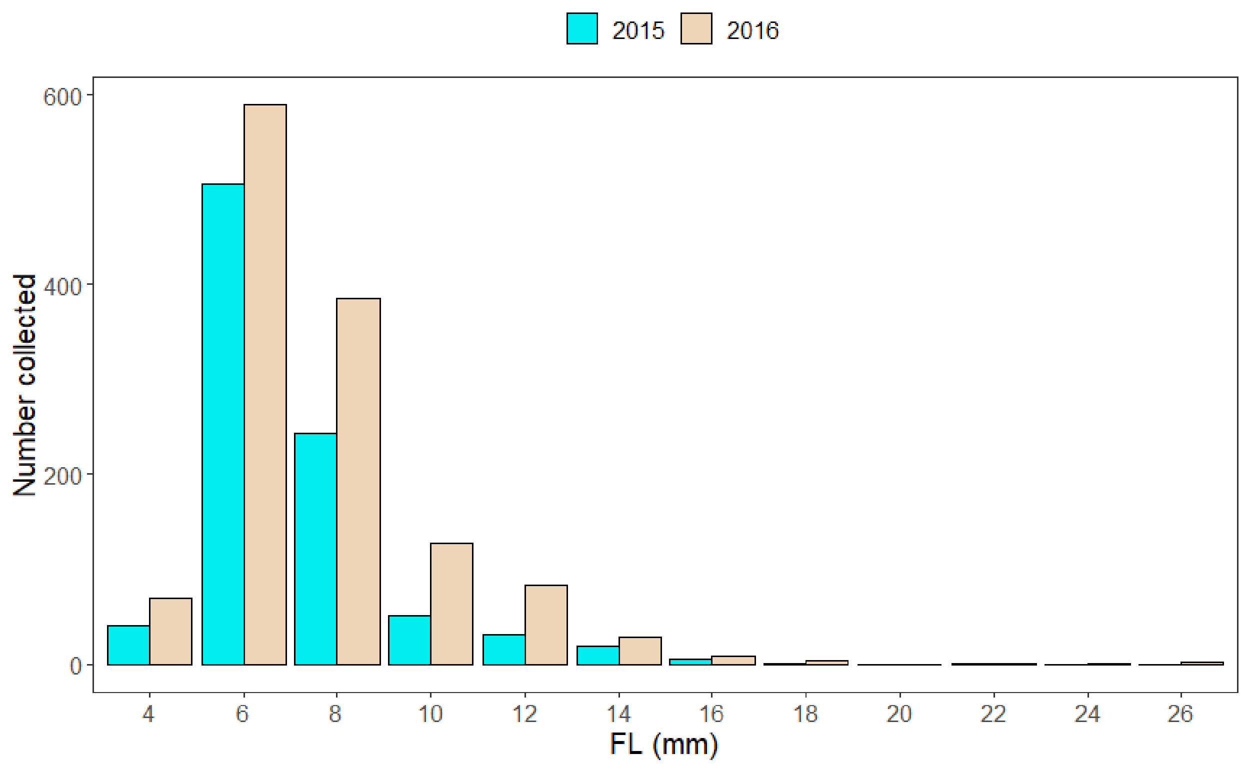
Most delta smelt spawning historically occurred February-April with most larvae hatching in March and April and peak catches of post-larvae in May and June. The Barker Slough Pumping Plant (BSPP) is a part of the SWP that has been in operation since 1988. It diverts water from Barker Slough in the Cache Slough Complex (CSC) and delivers it to Travis Air Force Base, Napa County, and the cities of Vallejo and Benicia via the North Bay Aqueduct (BA *Section 3.7.13*). The diversions sit at the upstream terminus of Barker Slough, a dead-end slough in an area of very low natural inflow. As a result, flow in Barker Slough is frequently net negative, meaning it is usually moving toward BSPP. The facility has a maximum diversion rate of 175 cfs, theoretically allowing for a little more than 125,000 acre-feet (125 TAF) of water to be diverted annually (BA *Section 3.7.13.1*). The PA says design capacity limits BSPP diversion to 26 TAF during January through March. Capacity then increases to 42 TAF during March through June. If BSPP pumped 175 cfs for all of January through March, it could divert about 31 TAF so it is not clear what limits capacity by 5 TAF. The March through June number is the theoretical maximum pumping output;

175 cfs daily for the 122 days in March through June would generate just over 42 TAF, so this is not a limit of any kind. The PA includes BSPP pumping limits of 60 to 100 cfs to protect delta smelt during March through June of Dry or Critical water year types if certain catch triggers based on 20-mm Survey sampling are met or exceeded (BA *Section 3.7.13.1.2.2*).

The BSPP diversions are very different from the South Delta fish facilities in that they have positive barrier fish screens in front of them that are operated to meet approach velocities of 0.2 $ft \cdot s^{-1}$ (~ 6 $cm \cdot s^{-1}$) to 0.4 $ft \cdot s^{-1}$ depending on the screen bay (DWR 2017, p. 3). The screens have a mesh size of 2.4 mm and are cleaned regularly to maintain the desired approach and sweeping velocities. Positive barrier fish screens work similarly to the diffusers on home aquarium filter intakes; they diffuse inflowing water over an enlarged surface area to slow down the flow rate as water is drawn into the intake (Poletto *et al*. 2015, their Fig. 1). The slower water moves toward an intake, the more likely it is that a fish will be able to swim away from it without being harmed. The pores in the fish screens at BSPP were designed to physically exclude fusiform fish more than about 25 mm in length (DWR 2017, their Figs. 3-4). This upper size limit to entrainment vulnerability means that fish can only be entrained for a finite period of time after they hatch.

DWR sampled fishes entrained through the BSPP fish screens during January-June of 2015 and 2016. Measured average approach velocities were usually ≤ 0.4 $ft \cdot s^{-1}$ and were usually slower near the water surface than at depth (DWR 2017 and 2019, Fig. 12 in both reports). Fish were pumped from the bays behind the fish screens into a large portable tank, then subsequently pumped through a 500-micron larval fish net to concentrate the catch (DWR 2017, their Figs. 16-18). The sampling collected 4,223 fish in 2015 (DWR 2017, p. 20) and 2,026 in 2016 (DWR 2019, p. 20). A large majority in both years were collected during 'regular' sampling, but some individuals (4-6%) were collected while the fish screens were being cleaned. Most of the individual fishes collected were 6-8 mm in length (Figure 8-15); the largest fish collected was 26 mm, very near the design criterion expectation of 25 mm. One delta smelt was collected in 2015 (DWR 2017, their Table 2) and none in 2016 (DWR 2019, their Table 2).

Figure 8-15: Summary of Fish Length Information Of Larval Fish Sampling Behind The Barker Slough Pumping Plant. Source Brian Schreier unpublished data.



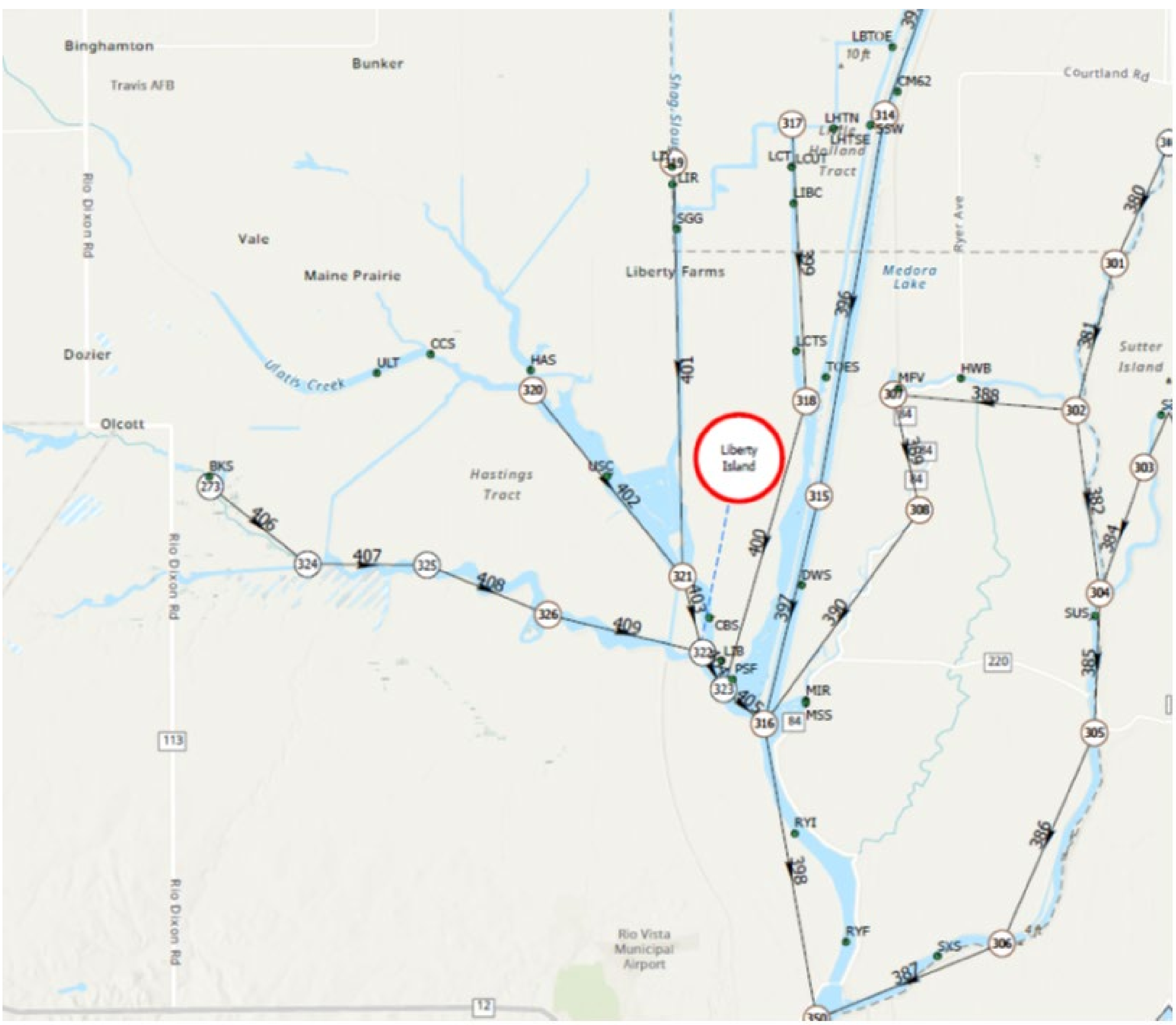
The Service ran DSM2 PTM for a wet year (2019) and a critically dry year (2021). We inserted particles at 9 release sites throughout the Cache Slough Complex on January 1, February 1, March 1, and April 1 of each year and tracked particle transport and fate for ~ 60 days in each run so that they ended on March 31, April 30, May 31, and June 30, respectively. The particle release locations are listed in Table 8-7 and shown in Figure 8-16. For each run, daily flux was recorded for particles moving in the Sacramento Deepwater Shipping Channel past node 315, into Lindsey Slough past node 325, into agricultural irrigation diversions, and into BSPP.

Table 8-7: List of particle release locations in the Cache Slough Complex used in DSM2

DSM2 node	Location	Graphic code
325	Lindsey Slough near its confluence with Barker Slough: this is the closest release location to BSPP	1.325
326	Lindsey Slough in between nodes 322 and 325: this is the second closest release location to BSPP	2.326
322	Confluence of Cache Slough and Lindsey Slough: this is the third closest release location to BSPP	3.322

321	Western side of Liberty Island/Cache Slough	4.321
316	Cache Slough near its confluences with the Sacramento Deep Water Shipping Channel and Lindsey Slough	5.316
315	Sacramento Deep Water Shipping Channel near the confluence with Cache Slough	6.315
308	Miner Slough	7.308
318	Eastern side of Liberty Island/Prospect Slough	8.318
314	Sacramento Deep Water Shipping Channel near channel marker 62	9.314

Figure 8-16: Map of the Cache Slough Complex Particle Release Locations



The PTM results predicted high spatiotemporal variability in the transport of particles to BSPP and agricultural diversions (range = 0 to 100%; Figure 8-17). Particles released closest to BSPP (node 325) were usually assured of being entrained into it. Particles released at the next closest node (326) also had a high predicted risk of entrainment into BSPP but everywhere else the likelihood of entrainment into BSPP was close to zero. Predicted losses to agricultural diversions were relatively high in some locations but showed no relationship to distance from BSPP. For particles released within Lindsey Slough, median predicted losses to BSPP were several times higher in the dry year (2021; Figure 8-18). There was also some interaction between predicted transport to agricultural diversions and BSPP for particles released into Lindsey Slough, especially at node 326 where transport to one or more agricultural diversions was predicted to occur faster than transport to BSPP, leaving smaller fractions of particles available to be transported to the latter (Figure 8-19).

Figure 8-17: Particle Fate from Cache Slough Complex

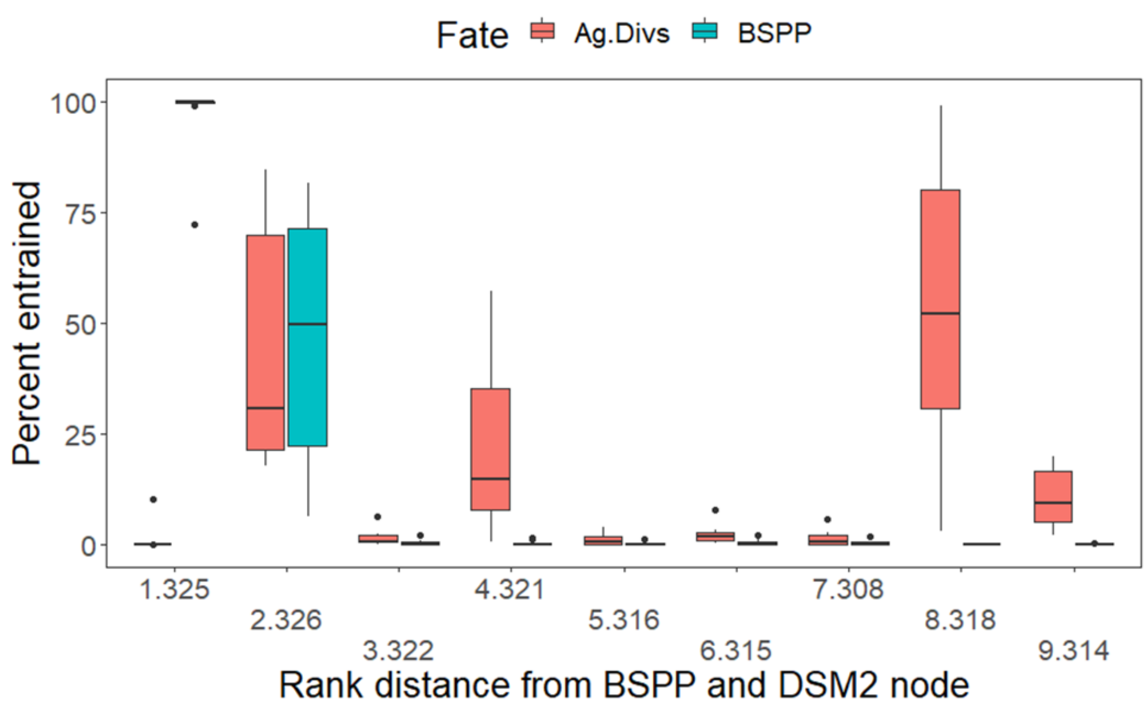


Figure 8-18: Particle Fates within Lindsey Slough in a wet year (2019) and dry year (2021)

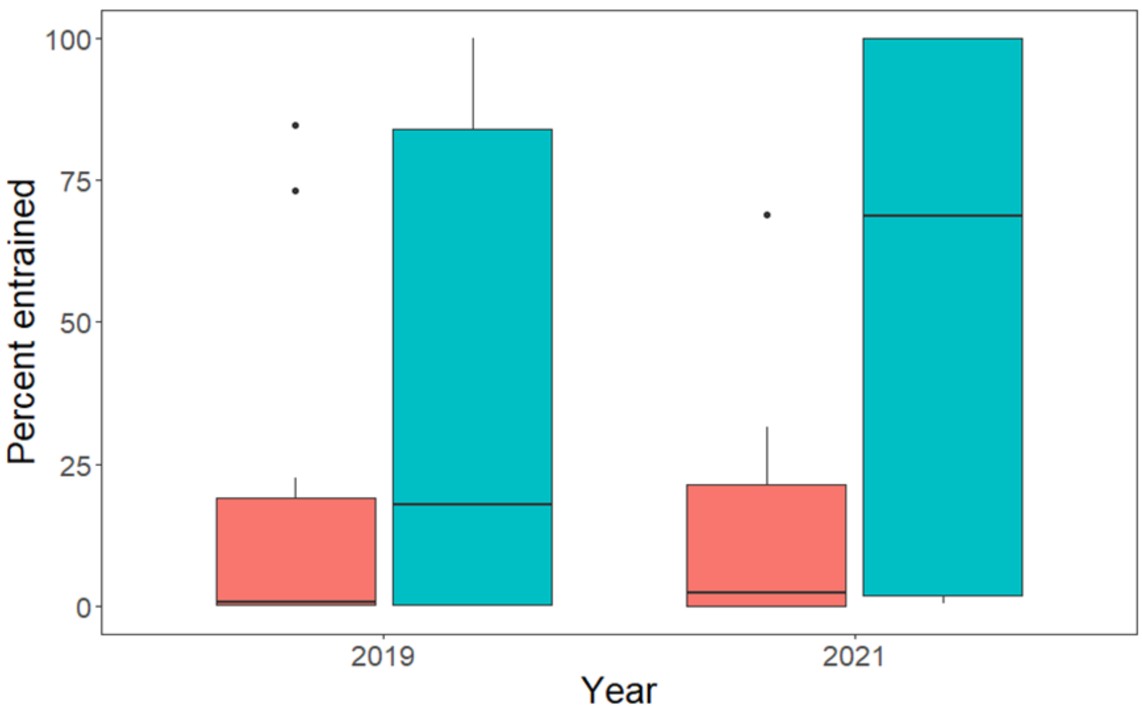
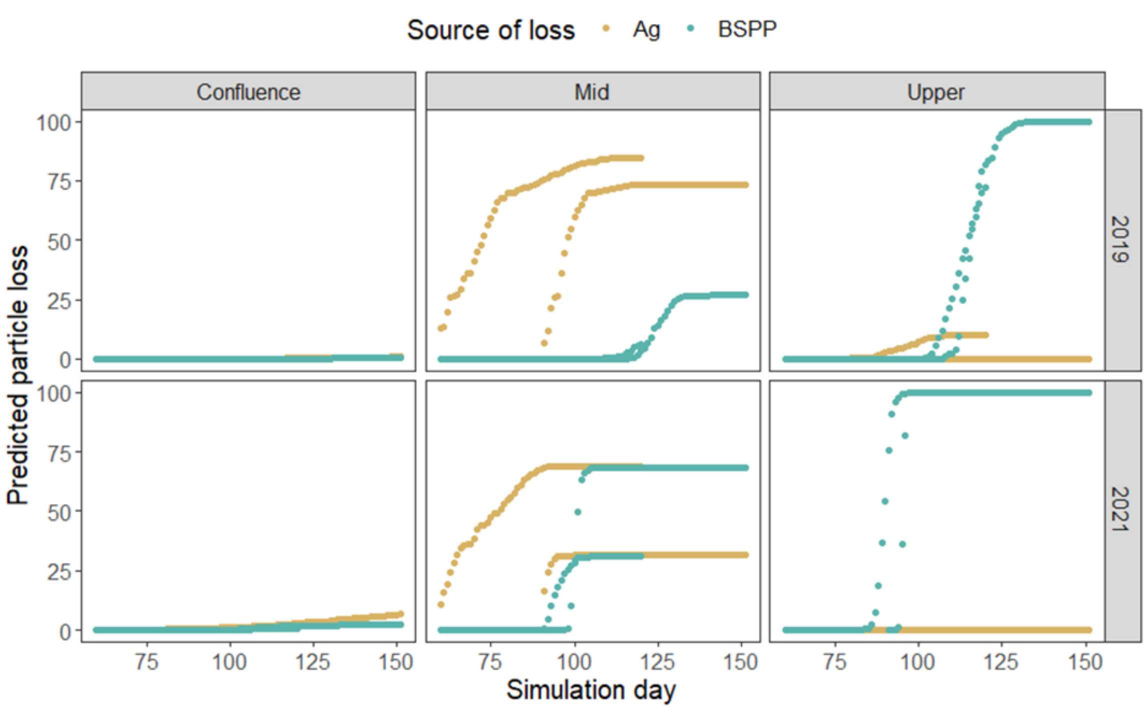


Figure 8-19: Timeseries of Particle Fates within Lindsey Slough



We incorporated information on historical delta smelt ‘natural’ mortality rate and growth rate (Figure 8-20) into the PTM results to generate indices of entrainment for the nine particle release locations each year. This approach also assumes the fish begin to be able to avoid entrainment as they approach 26 mm per Figure 8-15. When growth and mortality are considered, predicted entrainment from outside of Lindsey Slough is zero or very nearly so (Table 8-8). This nuanced use of PTM supports the qualitative conclusion that delta smelt spawned within Barker and Lindsey sloughs face a high risk of entrainment into BSPP or nearby irrigation diversions and delta smelt spawned outside of Lindsey Slough face almost no BSPP entrainment risk. Qualitatively, this conclusion appears to apply to both wet and dry years though predicted BSPP entrainment indices were higher in the dry year.

Figure 8-20: Delta Smelt Growth and Mortality Rates used in the Barker Slough Analysis

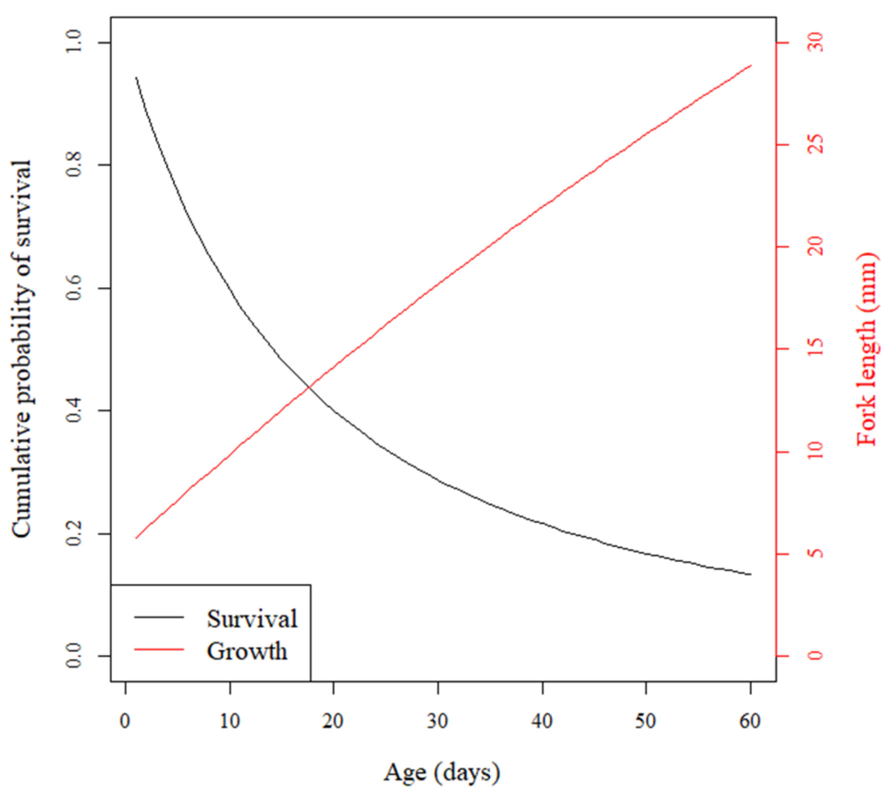


Table 8-8: Delta Smelt Entrainment Estimates in the Barker Slough Pumping Plant

Month/ Year	Upper Lindsey (1.325)	Lower Lindsey (2.326)	Lindsey confluence (3.322)	Liberty Island area (multiple)
Jan 2019	0.60	0.21	0	0.0002
Feb 2019	0.38	0.16	0	0
Mar 2019	0.01	0.0003	0	0
Apr 2019	0.31	0.057	0.0003	0
Jan 2021	0.65	0.41	0.002	0.003
Feb 2021	0.57	0.26	0.0005	0
Mar 2021	0.27	0.062	0.0005	0.0001
Apr 2021	0.73	0.40	0.008	0.004

Dry year entrainment could also increase if delta smelt have higher fractional spawning in Barker or Lindsey sloughs in dry years, a topic we discuss below. Delta Smelt historically spawned in the CSC and may continue to do so, though for the past several years, most putative spawners have been hatchery fish released in the vicinity of Rio Vista. Our results do indicate that Lindsey Slough, despite its relatively intact marsh habitat, would be a poor choice of release location for the delta smelt supplementation effort as it moves forward.

In recent decades, Lindsey Slough has not provided important delta smelt spawning habitat. The 1995 Delta Smelt biological opinion mandated an intensive larval fish monitoring program that sampled several locations in the CSC every other day during the delta smelt spawning season (Service 2005). Despite the intensity of the sampling effort, the program collected very few delta smelt larvae from in and near Barker Slough during 1995-2003, a time when delta smelt were far more numerous. However, it remained unclear whether the low catches were a result of entrainment quickly cropping fish hatching in the near-field environment or the result of only small numbers of delta smelt spawning in Barker or Lindsey sloughs. We think the PTM results suggest the information collected by the discontinued North Bay Aqueduct monitoring program reflected infrequent use of Lindsey Slough for spawning because the hydraulic transport times predicted by PTM are much longer than the two-day sampling interval. This conclusion is also reinforced by DWR's catch of only a single delta smelt larva in two seasons of extensive sampling behind the BSPP fish screens (DWR 2017; 2019).

Based on our analysis of the PA and its predicted effects we conclude:

- Entrainment effects of the Barker Slough Pumping Plant are almost completely limited to delta smelt that were spawned and hatched in Lindsey or Barker sloughs.

- These sloughs do not appear to have been historical or recent high use spawning habitats so the population scale effects of BSPP were and are likely small.

- We recommend that delta smelt supplementation efforts avoid using Barker or Lindsey sloughs as release sites.

Roaring River Distribution System (RRDS)

The RRDS is one of two water diversion and distribution systems operated by DWR that is used to increase the circulation of water for managed wetlands in Suisun Marsh. It diverts water through a screened intake off of Montezuma Slough near the SMSCG and distributes the water to wetlands south of Montezuma Slough. Under the PA, the RRDS will maintain a maximum approach velocity of 0.2 ft/second at the intake fish screens. During mid-September through mid-October, water diversions into RRDS increase to support a fall flood-up of wetlands to ready them for the arrival of winter waterfowl. During this one-month period, DWR proposes to divert water into RRDS at rates that result in approach velocities up to 0.7 ft/second. The RRDS intakes are screened (3/32-inch opening, or 2.4 mm) and physically exclude fish greater than 30 mm in length from being entrained. Therefore, operation of RRDS can entrain larvae and small juveniles in the spring and early summer. Once delta smelt grow to lengths greater than 30 mm, RRDS can only result in take if individuals are impinged onto the screens. It is not known whether and how often this occurs. Experimental evidence suggests that as approach velocities increase, the risk of impingement will as well (Swanson *et al*. 2005, their Fig. 2).

During March-June when delta smelt < 30 mm are present, after accounting for the fact that the delta smelt now exists only as an integrated hatchery-wild population and would likely be quickly extirpated if the annual re-introductions of "experimentally released" fish were discontinued,any effects on delta smelt would be expected to be similar between the NAA and PA because there has been no proposed change in the operation of RRDS and it affects a relatively small proportion of the overall population. By September and October all delta smelt exceed 30 mm in length and would therefore be able to avoid entrainment. Impingement is a more likely take mechanism for these juvenile fish. The 0.7 ft/second approach velocity may result in greater impingement on the screens than the 0.2 ft/second approach velocity. However, the Service considers higher entrainment or impingement mortality to be infrequent because the RRDS intakes are positioned in a part of Montezuma Slough where the channel is about 300 to 350 feet wide and delta smelt would need to be within a few feet of the fish screens to have any vulnerability to variation in approach velocities through the screens.

Morrow Island Distribution System (MIDS)

The MIDS is the second Suisun Marsh water distribution system. It diverts water off of Goodyear Slough through a set of unscreened intakes and redistributes the water in the westernmost parts of Suisun Marsh. Drainwater is eventually returned to Grizzly Bay. Under the PA, individual delta smelt could be entrained by the three unscreened 48-inch intakes that form the MIDS intake. However, Enos *et al*. (2007) noted that this would generally only occur in wet years. Enos *et al*. (2007) noted that under normal operations, MIDS is often closed, limiting diversions during spring. This lowers the frequency of entrainment opportunities and may provide some protection to spawning fish and their progeny. Enos *et al*. (2007) did not collect any delta smelt during sampling of the MIDS intake in 2004-2006, although they did capture adult delta smelt with purse seines during sampling in the adjacent Goodyear Slough. Historically, during summer and fall elevated salinity in the western Suisun Marsh would also have limited delta smelt exposure to MIDS. However, the use of SMSCG to lower the salinity of the marsh in the summer and early fall for the Delta Smelt Summer-Fall Habitat Action may have changed this somewhat. Based on the Enos *et al.* (2007) finding that delta smelt can occupy Goodyear Slough without being entrained, we expect entrainment loss will continue to be minimal on an individual and population level. The Service expects that mortality is likely to occur when individual delta smelt enter the intakes because we consider it unlikely that delta smelt would survive on the managed wetlands given their extremely shallow wetted depths.

Delta Cross Channel

Reclamation uses the Delta Cross Channel (DCC) to divert Sacramento River water into the South Delta via the north and south forks of the Mokelumne River (BA *Section 3.7.2*). The use of these gates has several benefits to the project, but their use can also entrain emigrating salmonids into the South Delta where survival is lower. The BA describes a range of DCC operations in *Section 3.7.2.1* through *Section 3.7.2.6*. This includes full-time gate closure from February 1 through May 20 each year (BA *Section 3.7.2.4*).

Adult delta smelt and their progeny have occasionally been collected in the vicinity of the DCC (Merz *et al*. 2011, their Fig. 6), but the Service considers this a transiently used area that supports a small fraction of total spawning. The DCC gates may or may not be open during December-January when many adult delta smelt are searching for spawning habitats (BA *Section 3.7.2.3*). They will be closed for several months thereafter (BA *Section 3.7.2.4*). Opening and closing the DCC gates may change where these delta smelt end up, but it is not known whether such relocation has a consequence to survival similar to what has been demonstrated for Chinook Salmon smolts. It is likely that larvae hatching along the Sacramento River upstream of the DCC will more or less be passively distributed downstream, but essentially all of this transport is expected to occur during the period of full gate closure from February 1 through May 20. Given infrequent DCC gate operation during the spawning season and the Service's lack of information suggesting an effect on delta smelt resulting from operation of the DCC, effects to the species are not anticipated.

South Delta Facilities and Maintenance

The Service considers all delta smelt to have been entrained and therefore 'lost' to the population once they enter Old or Middle rivers. The PA includes OMR actions designed to limit entrainment. As such, any effects of operation of the Tracy Fish Collection Facility (BA *Sections 3.7.3*, *3.7.7* and *3.7.7.1*), Skinner Fish Protection Facility (BA *Sections 3.7.8*, *3.7.8.1*, and *3.7.8.2*), the Clifton Court Aquatic Weed Management (BA *Section 3.7.14*), Agricultural Barriers (BA *Section 3.7.12*), B.F Sisk Dam Raise and Reservoir Expansion Project (BA *Section 3.7.15*), and Contra Costa Water District Rock Slough Intake operations have already been evaluated above and are not evaluated further. The Rock Slough intake is north of the Banks and Jones pumping plants and their affiliated fish facilities, but the Rock Slough diversion has a positive barrier fish screen and a maximum diversion rate of 350 cfs so it does not meaningfully affect our analysis of delta smelt entrainment effects in the South Delta.

Water Transfers

Reclamation and DWR propose to operate the CVP and SWP to facilitate transfers by providing water in streams for delivery to alternative diversion points, conveying water across the Delta for export, or storing water for delivery at a future time. The PA includes transfers of water, up to contract totals, between CVP contractors within counties, watersheds, or other areas of origin (e.g., Accelerated Water Transfers). Transfers not meeting these requirements, including Out of Basin transfers (e.g., Long Term Water Transfer Program (North to South-of-Delta Transfers, Long Term San Joaquin River Exchange Contractor Transfers, “Warren Act Transfers”), follow a separate process and are not included in this consultation.

The actions taken by contractors to make water available for transfers (i.e., reducing consumptive use by crop idling, contractor reservoir releases or groundwater substitution) are addressed under separate consultation as described in the Environmental Baseline; therefore, effects from making the transfer water available are not addressed in this consultation as effects of the PA. However, the specific timing and operations associated with the movement of the water to be transferred is a component of the LTO PA and is covered by this consultation.

Reclamation and DWR will provide a transfer window across the Delta from July 1 through November 30. When pumping capacity is needed for CVP or SWP water, Reclamation and DWR may restrict transfers. Maximum transfers are shown in Table 14 in Section 3.7.12 of Appendix 2 - Proposed Action.

Water transfers would be subject to all measures applicable for the Delta, including Seasonal Operations (BA *Section 3.7.1*) and Old and Middle River Flow Management (BA

Section 3.7.4). Therefore, we do not anticipate additional effects to delta smelt resulting from water transfers.

Drought Toolkit

Drought is a serious concern for delta smelt given the differences in population growth rate predicted for wetter versus drier years (Table 8-6). Reclamation proposed the development of a Drought Toolkit (BA *Section 3.12*). The BA outlines a process for development, coordination, and implementation of these actions. However, no description of these actions and if or how these actions would be designed and implemented were provided in time to incorporate into the effects analysis of this BiOp. Therefore, the Service is addressing the actions in the Drought Toolkit under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp.

Drought or dry year actions that were mentioned in the BA as possible elements of the Drought Toolkit include: rebalancing between other CVP reservoirs with moderate impacts to other parts of the system, transfer timing modifications, situation-specific adjustments to Delta water quality standards under D-1641 to address developing drought conditions and other actions, designing habitat projects with drought refugia and resilience in mind, and investments in other habitats for salmon spawning. Planning and implementation of actions will depend on various factors that are not known at this time, such as locations and extent of particular actions and where or if they may overlap with listed species habitat.

The framework proposed for development of drought or dry year actions involves the following collaborative process. The Drought Relief Year (DRY) team will meet at least monthly starting in October to assess if drought conditions are developing or are present. If warranted, this team will review actions in the Drought Toolkit and determine if it would be appropriate to pursue any of them and evaluate the effectiveness of those actions.

As described in Section 3.13 Governance of the BA, the Water Operations Management Team (WOMT) and Shasta Operation Team (SHOT) will coordinate with each other as needed on operational issues and decisions that have implications for both of their respective purviews, including but not limited to Drought Toolkit implementation.

CVP/SWP operation for proposed actions from the Drought Toolkit like drought barriers will require modeling and analysis. Operation with drought barrier(s) in place, in addition to drought conditions themselves, are likely to alter hydrodynamics within the Delta, exacerbate poor water quality conditions in the west Delta further limiting habitat availability, improve water quality conditions in the central Delta, and increase harmful algal blooms and aquatic invasive vegetation. These hydrodynamic changes are likely to affect delta smelt.

As described in the *Consultation Approach* section of this BiOp, a framework programmatic approach is used for proposed actions that will require subsequent consultations to address effects to listed species and critical habitat, and no incidental take is likely to occur until those subsequent consultations are completed. Reclamation proposes to request initiation of section 7 consultation for any actions proposed to be implemented from the Drought Toolkit that may affect species or critical habitat.

Reclamation and DWR will coordinate with the Service on design of Drought Toolkit actions via the DRY team. Detailed information regarding the location, extent, overlap with listed species habitat and designated critical habitat, timeframe, and other relevant information will be developed for each action. Reclamation will prepare a Biological Assessment for each Drought Toolkit action that may affect listed species or critical habitat and provide to the Service with adequate time to complete the necessary subsequent consultations.

Monitoring

Monitoring is used to help us understand the effects of operations of the CVP and SWP, including when to implement protective measures to avoid and minimize the effects of the Proposed Action by informing specific real-time actions. Ongoing monitoring is addressed under separate section 7 consultations and section 10(a)(1)(A) permits that are described in the Environmental Baseline; therefore, adverse effects of ongoing monitoring are not addressed in this BiOp as effects of the PA.

Reclamation and DWR propose a framework programmatic consultation approach to address future changes to ecosystem and species monitoring associated with the PA. Subsequent changes to existing monitoring programs would be coordinated amongst the involved agencies and would require subsequent consultation. Changes outside the scope and effects in the existing consultations and permits are not authorized to commence until subsequent consultation is completed. The framework programmatic consultation approach includes several principles which would be incorporated into any future changes to monitoring programs addressed in a subsequent consultation (BA *Section 3.10*). These principles include assurances that effects from monitoring to listed species are minimized, and that the information is synthesized and is coordinated with the proposed Adaptive Management Program (BA *Section 3.14*) to inform operational decisions and potential future modifications to operational measures. A multi-agency structure would be developed to make decisions about how monitoring would be implemented, further assuring that monitoring deployment is designed to meet all objectives.

Spring Delta Outflow/Healthy Rivers and Landscapes Program **(March through May)**

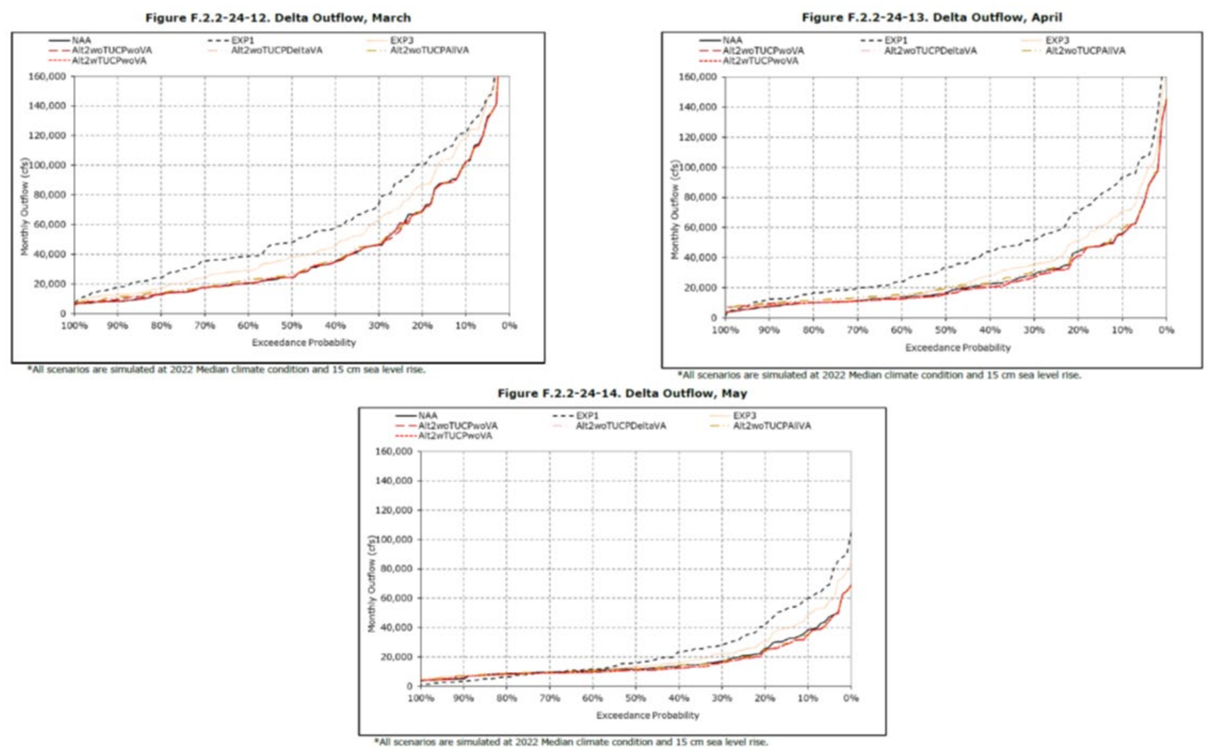
The historical delta smelt spawning season extended well into the spring (Damon *et al*. 2016, their Table 3; Table 8-4). This has led to long-standing concerns about the influence of hydrodynamic conditions in the spring, including Delta outflow, on recruitment (Moyle *et al*. 1992, pp. 72-74). It is logical to have expected delta smelt population dynamics to respond to large interannual variations in wet season Delta outflow like longfin smelt and several other estuarine fishes have but evidence for the effect was generally not forthcoming (e.g., Moyle *et al*. 1992, p. 74; Bennett 2005, his Fig. 19; Thomson *et al*. 2010, their Fig. 3c). It appeared that a spring outflow effect may have emerged in the decade or so following the Pelagic Organism Decline (Baxter et al. 2015, their Fig. 82) but newer life cycle modeling has not supported that effect (Polansky *et al*. 2021, their Tables C.2 and C.4; Polansky *et al*. 2023, their Table S3.3). Rather, the springtime effects on population dynamics appeared to be related to the ability of adult fish to generate repeat spawns because the best recruitment predictors were water temperature and a prey metric that applies to the adult fish (Polansky *et al*. 2024, their Table 1). The variation in springtime conditions represented in the different variations of the PA was included in the LCME projections of population growth rate that show no discernable differences among alternatives (Figure 8-13).

As described in the "Spring Delta Outflow/Healthy Rivers and Landscapes Program" subsection under the *Consultation Approach* section above, this BiOp addresses the pre-adoption period as a standard consultation and the pre-adoption period as a framework programmatic consultation. If the HRL program is fully implemented, the Delta could receive an average of 150 TAF, 825 TAF, 751 TAF, 826 TAF, and 155 TAF of additional outflow in Wet, Above-Normal, Below-Normal, Dry, and Critical water year types, respectively (BA Table 3-12). In addition, DWR has accounted for an SWP portion of the HRL program focused on Above-Normal, Below-Normal, and Dry water year types (*ITP application Table 16*) and included an HRL pre-adoption implementation plan that can be implemented in one of two ways to generate conditions in the Delta similar to what was in CDFW's 2020 ITP condition of approval 8.17 (*ITP application Section 3.3.3.2*). The pre-adoption HRL actions are proposed to increase Delta outflow via temporary reduction of exports from the South Delta. At face value, whether the HRL program is implemented or not, CalSim 3 modeling suggests the statistical distributions of Delta outflow in the spring months would remain very similar to the NAA (Figure 8-21).

Based on our analysis of the PA and its predicted effects we conclude:

- the additional spring Delta outflow proposed in the HRL may have incremental beneficial effects on delta smelt, predominantly by lowering entrainment, as compared to the NAA.

If the SWRCB does not approve the HRL or the parties do not execute the agreements in order to implement the HRL, reinitiation of this consultation may be necessary. Figure 8-21: Exceedance Plats of CalSim3 Predictions of Delta Outflow



Delta Smelt Summer-Fall Habitat Action (July through October)

During the summer and fall most delta smelt are in their juvenile life stage and experiencing multiple physiological stressors (Table 8-9). The PA includes supplementation of the delta smelt population in the winter to help rebuild the wild stock and comprehensive OMR management throughout the winter and spring to lessen the risk of entraining too many fish. Supplementation bolsters egg supply and has to date visibly increased catches of larval delta smelt in monitoring programs over where they were just a few years ago (Figure 8-24). However, each new generation of fish spawned in the wild needs to survive at a reasonable rate for a supplementation effort to have long-term utility. The use of life cycle models helps to put potential actions into context and better align the temporal effects of environmental conditions with variation in delta smelt recruitment and survival. The purpose of the Delta Smelt Summer-Fall Habitat Action is to try to improve delta smelt survival during this physiologically challenging time of year. The action targets the survival of juvenile fish during what are often the warmest months of the year when water temperatures in the upper estuary can approach or exceed levels that can sustain growth, turbidity in the Delta declines as spring flows recede, and low-salinity zone prey densities are depleted by overbite clam grazing. The action is actually several actions: re-operation of the Suisun Marsh Salinity Control Gates (SMSCG) to lower salinity in Suisun Marsh in Dry, Below-Normal, and Above-Normal water years, and a 'Fall X2' action to lessen salinity in Suisun Bay and Suisun Marsh in Wet and Above-Normal water years.

Table 8-9: Summary of delta smelt life history for the months of June through November. Green and Yellow Shading Aligns with LCME (Smith et al. 2021).

Month	Spawning cohort (historical)	Progeny of spawning cohort (historical)	Contemporary observations
Jun	Life Stage: Essentially complete end of the spawning season and cohort life though a few individuals would persist and survive to a second spawning season (Bennett 2005, his Fig. 13A; Damon *et al*. 2016, their Fig. 9)	Life Stage: post-larvae and juveniles; Larval emergence concluded and in cool years, June was peak recruitment to 20-mm Survey gear (Bennett 2005, his Fig. 11A) LCME Life Stage: post-larvae 2 Habitat: predominantly turbid freshwater distribution near ~ 0-1 psu (Kimmerer *et al*. 2013, their Fig. 6) but increasingly absent from the South Delta as water clarity increased Peak historical salvage continued (Kimmerer 2008, his Fig. 3) LCME recruitment covariates: OMR, South Delta Secchi depths	Salvage of age-0 delta smelt in June has not been observed since 2013 Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity was predicted to chronically limit foraging upstream of the Sac-San Joaquin confluence; predicted onset of thermal stress in the Delta in 2017 and 2020; Suisun Bay was food limiting in 2016 but not other years (Smith and Nobriga 2023, their Fig. 3)
Jul		Life Stage: predominantly juvenile (≥ 25 mm)	Salvage in July has not been observed since

		LCME Life Stage: juvenile Habitat: Predominantly the North Delta Arc in turbid open surface waters with ~ 90% collected at salinity lower than ~ 4 psu (Bennett 2005, his Fig. 5) and catches declining rapidly at temperatures higher than 20°-22°C (Komoroske et al. 2014, their Fig. 3) Salvage concluded (Kimmerer 2008, his Fig. 3) LCME survival covariates: Delta Outflow (June-August)	2008 Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity and high temperatures were both predicted to chronically limit foraging upstream of the Sac-San Joaquin confluence; Suisun Bay was food limiting in July except in wet years (Smith and Nobriga 2023, their Fig. 3)
Aug		Life Stage: predominantly juvenile LCME Life Stage: juvenile Habitat: Predominantly the North Delta Arc in turbid open surface waters with ~ 90% collected at salinity lower than ~ 4 psu (Bennett 2005, his Fig. 5) and catches declining rapidly at temperatures higher than 20°-22°C (Komoroske et al. 2014, their Fig. 3) LCME survival covariates: Delta Outflow (June-August)	Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity was predicted to chronically limit foraging upstream of the Sac-San Joaquin confluence; periodic thermal stress was observed in the Delta and Suisun Bay; Suisun Bay was consistently food limiting in August (Smith and Nobriga 2023, their Fig. 3)
Sep		Life Stage: predominantly juvenile LCME Life Stage: not modeled Habitat: Predominantly North Delta Arc in turbid open surface waters; beginning about this time and extending through November or	Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity was predicted to chronically limit foraging upstream of the Sac-San Joaquin

		December, ~ 90% of the fish were collected at salinity lower than ~ 6 psu (Bennett 2005, his Fig. 5) with a long-tailed salinity distribution extending out to ~ 20 psu (Nobriga and Smith 2020, their Fig. 5)	confluence; thermal stress extended into September in 2017, 2019 and 2020; Suisun Bay was consistently food limiting in September (Smith and Nobriga 2023, their Fig. 3)
Oct		Life Stage: predominantly juvenile LCME Life Stage: sub-adult 1 Habitat: same as September LCME survival covariates: Secchi disk depth (September-November) and striped bass abundance index	Putative offspring of experimental release fish have been captured in EDSM During 2016-2020, low turbidity was predicted to chronically limit foraging upstream of the Sac-San Joaquin confluence; thermal stress abated but food was chronically limiting in Suisun Bay in October (Smith and Nobriga 2023, their Fig. 3)
Nov		Life Stage: predominantly juvenile and subadult LCME Life Stage: sub-adult 1 Habitat: same as September LCME survival covariates: Secchi disk depth (September-November) and striped bass abundance index	Putative offspring of experimental release fish have been captured in EDSM Estuary water temperatures typically returned into the optimum range that is used in aquaculture (~ 16°C) Experimental releases have occurred; to date, survival of these releases has been lower than for fish released in other months

Prior to the early 2000s, survival of delta smelt over the summer and into the fall was periodically low (Nobriga and Smith 2020, their Fig. 6). Thereafter, summer-fall survival became more frequently problematic (Polansky *et al*. 2024, their Fig. C.1) and statistically associated with Delta outflow (and corollaries) during the summer (~ June-August; Table 8-10). In contrast, statistical importance of Delta outflow (and corollaries) on delta smelt survival in the fall (~ September-November) is not visible in the best information we now have available to us.

Table 8-10: Summary of Summer and Fall Flow Results from USFWS LCMs

Study	Model variations tested	What was being tested	Summer flow results	Fall flow results
Polansky *et al*. (2021) supplemental information, Tables C.2 and C.4	9	Initial screen of a large set of covariates (Table C.2) but also whether to let the MCMC estimate the model's observation error (OE) coefficient of variation (CV) (Table C.4)	Inflow: 'slope' = 0.18 to 2.09; fraction of Bayesian posterior > 0 = 0.99 Outflow: 'slope' = 0.24 to 2.50; fraction of Bayesian posterior > 0 = 0.99 EI ratio: 'slope' = -1.19 to 0.63; fraction of Bayesian posterior < 0 = 0.76 X2: 'slope' = -1.84 to -0.15; fraction of Bayesian posterior < 0 = 0.99 Prey biomass: 'slope' = 0.18 to 1.99; fraction of Bayesian posterior > 0 = 0.99 Tested: outflow volume Fixed OE CV: 'slope' = -0.25 to 1.72; fraction of Bayesian posterior > 0 = 0.93 Estimated OE CV:	Inflow: 'slope' = -1.01 to 0.69; fraction of Bayesian posterior > 0 = 0.36 Outflow: 'slope' = -0.66 to 0.84; fraction of Bayesian posterior > 0 = 0.63 EI ratio: 'slope' = -1.03 to 0.58; fraction of Bayesian posterior < 0 = 0.72 X2: 'slope' = -0.79 to 0.79; fraction of Bayesian posterior < 0 = 0.49 Prey biomass: 'slope' = -1.01 to 0.48; fraction of Bayesian posterior > 0 = 0.24 Tested: X2 Fixed OE CV: 'slope' = -0.72 to 0.81; fraction of Bayesian posterior < 0 = 0.47 Estimated OE CV:

			'slope' = -0.49 to 1.53; fraction of Bayesian posterior > 0 = 0.87	'slope' = -1.06 to 0.61; fraction of Bayesian posterior < 0 = 0.63
Polansky *et al*. (2023) supplemental information, Table S3.3	3	The importance of assumptions about relative gear efficiency or 'bias' M0: all gears have equal efficiency M1: SKT and 20-mm Survey have equal efficiency M2: SKT has the highest efficiency	Tested: outflow volume M0: 'slope' = 0.17 to 1.59 M1: 'slope' = 0.30 to 2.47 M2: 'slope' = 0.08 to 2.22	Tested: low-salinity zone volume M0: 'slope' = -0.55 to 0.58 M1: 'slope' = -0.72 to 0.77 M2: 'slope' = -0.45 to 0.59
Polansky *et al*. (2024) Tables 1 and 2, and supplemental information, Table B.1	10	Evaluated evidence for density-dependence; Allee effect and carrying capacity	Tested: outflow volume M7 (ΔAIC = 0): 'slope' = 0.38 to 2.42 M3 (ΔAIC = 1.40): 'slope' = 0.38 to 2.38 M5 (ΔAIC = 5.07): 'slope' = -0.05 to 1.83 M1 (ΔAIC = 6.96): 'slope' = 0.05 to 1.83	Tested: outflow volume M7: Not included M3: Not included M5: 'slope' = -0.43 to 0.69 M1: 'slope' = -0.40 to 0.68

The mechanisms that cause delta smelt survival to covary with Delta outflow are not known with certainty nor is the timing of when that outflow is most important (Polansky *et al*. 2024, p. 11). However, the best available information suggests that the 'mechanism' for the correlation is related to foraging habitat alignment for juvenile fish as described by Smith and Nobriga (2023). Multiple factors can present the biggest limit to foraging success at any given time but some of the bigger picture patterns are summarized in Table 8-9. The conditions expected to reduce juvenile delta smelt foraging capability down to 75% of maximum potential are a water temperature above 22.8°C, a turbidity lower than 9 NTU, or a species-weighted copepod biomass density lower than 2.7 mg of carbon per square meter (Will Smith USFWS, personal communication). Foraging habitat constraints vary in space and time, but good feeding conditions tend to best overlap in the regions comprising Suisun Bay (Smith and Nobriga 2023, their Figs. 3 and 5). Higher Delta outflow lowers the salinity of Suisun Bay (and Marsh) which provides delta smelt with greater access to broad shallow shoals and comparatively productive marsh channels. These locations frequently also have better temperature and turbidity conditions than the Delta (Smith and Nobriga 2023, their Fig. 3).

In addition to aligning physical elements of foraging habitat, the seasonality of prey production may interact with Delta outflow to contribute to the summer flow correlation. The copepod *Pseudodiaptomus forbesi* is the primary prey for delta smelt during the summer and early fall (Slater and Baxter 2014, their Table 2). Per the "Condition of the estuary food web" subsection in the *Environmental Baseline* section above, *P. forbesi* is the primary prey because it is the most abundant zooplankter in delta smelt's summertime foraging habitats that is of a size the fish can efficiently capture enough of in the time that they have available to feed each day. Delta outflow generates a flux of *P. forbesi* from its freshwater source areas in the Delta into the low-salinity zone (Kimmerer *et al*. 2019). Once there, early life stages of *P. forbesi* suffer high grazing and predation rates so it would not be able to persist in the low-salinity zone but for continual replenishment (i.e., subsidy) from the Delta. The biomass of *P. forbesi* is at its seasonal maximum in the summer so the flux of food to delta smelt per unit of outflow is highest at that time. The population of this copepod begins to senesce in the fall as estuary waters cool off and the population reaches its annual minimum in the winter and early spring.

The PA has no summer outflow 'action' explicitly intended to help with delta smelt conservation, but we analyze summer outflow effects here because Reclamation and DWR elevate Delta outflow during July through October above what would occur in the absence of the projects (Figure 8-4). They do this to create a 'hydraulic salinity barrier' that accomplishes two primary goals: 1) maintain salinity standards mandated by the SWRCB to protect the water rights of senior water rights holders in the Delta, and 2) maintain the quality of exported water (Reis *et al*. 2019, p. 8). Thus, summer outflow augmentation is an aspect of CVP and SWP operations.

Polansky *et al*. (2024, their Fig. 5b) estimated what magnitude of summer outflow action would be needed to generate a 50 percent chance of positive delta smelt population growth, acknowledging that a 50 percent chance is not very high. They estimated the fraction of total Delta inflow that would be needed during June through August varied by water year type but ranged from near 50 percent in Wet years to about 100 percent in Critical years. From a water supply perspective, these are very high fractions but they are probabilistic estimates so there may be circumstances when measurable benefits could be achieved with smaller outflow augmentations. Adaptive experimentation with this could be helpful to determine if measurable benefits could be achieved by shifting some flow augmentation to summer months.

The differences between June through October Delta outflow from CalSim 3 modeling are shown in Figure 8-22. The results suggest the model was trending toward lower outflow in July and August, but most differences in the PA variants were within about 500 cfs of the NAA suggesting they are mostly within model 'noise' or 'error'. The largest predicted changes from the NAA are on the drier side of the June and July exceedances where CalSim 3 predicted outflows up to about 1,000 cfs higher than the NAA in several PA variants. These predicted changes in Delta outflow did not translate into discernable differences in life cycle model predictions of delta smelt population growth rate (Figure 8-12). In the PA application of LCME, the 21-year geometric mean population growth rate was 0.97 in the NAA and ranged from 0.94 to 0.98 in the four variations of Alt 2 (Table 8-6). The MDR model was even less sensitive to the CalSim 3 variations though it predicted much lower population growth rates overall; the geometric mean in the NAA and all four Alt2 variations was 0.75 (BA *Appendix F, Attachment F, Table 5*). Thus, the MDR model predicts a much steeper abundance decline than LCME under any and all versions of contemporary environmental conditions.

Figure 8-22: Differences in June through October Delta outflows relative to the No Action Alternative (NAA)

The Delta Smelt Summer-Fall Habitat element of the PA is intended to help mitigate low summer-fall survival; it includes operation of the (SMSCG during summer and fall (BA *Section 3.7.6.2*). The PA is not clear whether SMSCG operations needed to meet D-1641 salinity standards in the marsh would also count toward the delta smelt action if the two were occurring at the same time. The proposed use of the SMSCG varies by water year type as summarized in Table 8-11). The SMSCG action was originally proposed as part of California's Delta Smelt Resiliency Strategy (Natural Resources Agency 2016) and was motivated by a study that found delta smelt collected from Suisun Marsh had performed relatively well across eight health indicators and especially well in two biomarkers of liver health (Hammock *et al*. 2015, their Fig. 2).

Table 8-11: Summary of Proposed Operations of The Suisun Marsh Salinity Control Gate for Delta Smelt Habitat Enhancement.

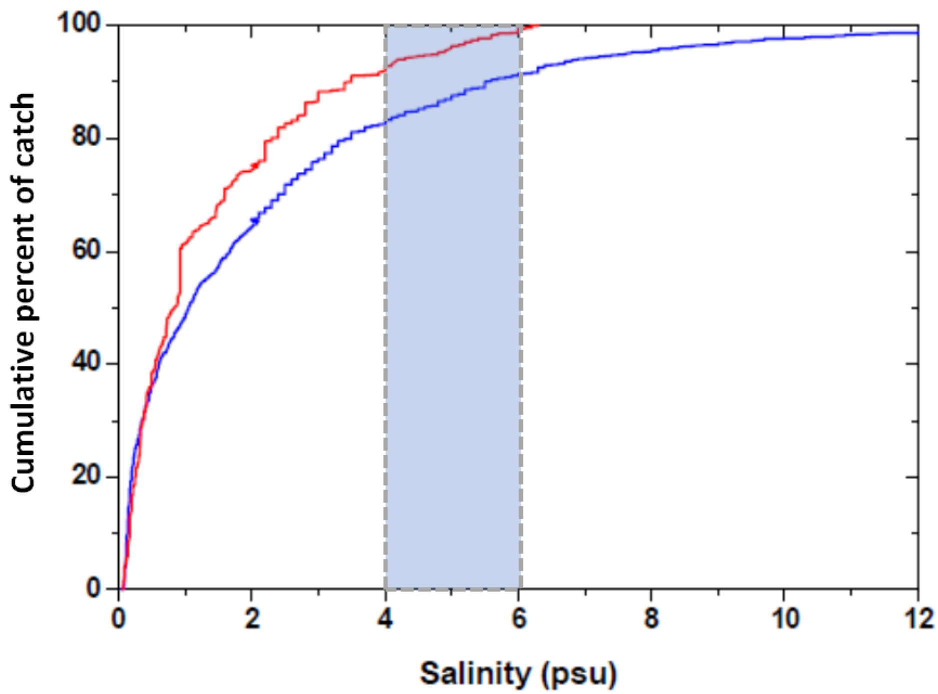
Water Year Type	Gate operation	Salinity target (PSU)
Wet	None	None
Above-Normal	60 days	4

Below-Normal	60 days	4
Dry	*Following a Wet or Above-Normal year*: 60 days *Following a Below-Normal year*: 30 days and as required to meet D-1641 salinity standards in Suisun Marsh	4 6
Critical	Only as needed to meet D-1641 salinity standards in Suisun Marsh	None

The SMSCG was built to pump Sacramento River water into Montezuma Slough to freshen the waterways of Suisun Marsh. Historically, the operation of the SMSCG has helped Reclamation and DWR meet salinity standards in Suisun Marsh at lower water cost than trying to meet them using Delta outflow. The gates work by being opened during ebb tides to preferentially bring fresher Sacramento River water into the marsh, then being closed on the flood tide (Sommer *et al*. 2020, their Fig. 2). Closing the gates on the flood tides helps to hold the freshened water in the marsh. Repeating this sequence over multiple tidal cycles lowers salinity. A lot of Suisun Marsh is leveed which disconnects waterways from considerable managed wetland area (Moyle *et al*. 2013, p. 2). Water gets distributed onto these managed wetlands with the help of numerous water diversions. In general, the diversion and distribution of water onto the Suisun Marsh wetlands is highest during the fall because wetland managers start filling ponds in preparation for the winter arrival of migratory waterfowl.

Pumping Sacramento River water into Montezuma Slough as part of the PA will provide a semi-continuous flux of *P. forbesi* into the marsh via passive transport of this zooplankter. Some delta smelt may likewise be passively moved into Montezuma Slough as well, while others may volitionally find their way from more brackish waters in Suisun Bay. This series of events is expected to increase foraging habitat suitability for individual delta smelt that find their way to it and those already present in the marsh; particularly its bigger channels like Montezuma Slough and Suisun Slough that provide relatively large pelagic habitat areas. If the contemporary integrated delta smelt population distributes in salinity space similarly to the historical wild population, then during June through August we expect an upper bound of about 10 percent of the juvenile delta smelt population to be potentially affected by the SMSCG action (Figure 8-23). By fall, we expect the upper bound to rise to about 20 percent of the population. Based on these historical catches, we do not expect the operation of the SMSCG to meet a salinity of 6 PSU in Dry water years to have much if any positive effect on delta smelt until the fall when they begin to occupy water with a salinity that high.

Figure 8-23: Historical Distribution of Delta Smelt Catches Relative to Salinity. Source Bennett (2005).



Delta smelt that are foraging within Suisun Marsh will face an unquantified entrainment risk that is higher than what is experienced in Suisun Bay or the Sacramento-San Joaquin River confluence. The stronger tides and reticulate channel networks of Suisun Marsh make it more difficult to predict entrainment risk than in the South Delta (Culberson *et al*. 2004, pp. 261-263). Our assumption is that entrainment risk is highest in the fall when the waterfowl clubs begin their fall flood up. Water diverted in the marsh is eventually returned to adjacent channels or into Grizzly Bay. Some fish species can survive the process of being entrained onto managed wetlands and then eventually pumped back off. The ability of delta smelt to survive in shallow ponded habitats has not been evaluated but seems unlikely during the relatively warm summer and early fall.

The Delta Smelt Summer-Fall Habitat Action also includes a Fall X2 element (BA *Section 3.7.6.1*). The Fall X2 action is a 'pulse flow' in September of Wet and Above-Normal water years that carries over into October, which is officially the subsequent water year. As proposed, the pulse of freshwater would maintain a 30-day average X2 at 80 km in both months. The Fall X2 action was originally in the Service's 2008 Reasonable and Prudent Alternative (Service 2008) and was motivated by concerns about proposed 'flatlining' of habitat suitability in the autumn (Feyrer *et al*. 2011, p. 124 and their Fig. 5). The modeled Delta outflows for September and October are about the same in the PA as the NAA (i.e., within the CalSim 3 error) so there is no proposed change from baseline (Figure 8-22). Currently proposed outflows in September and October are lower than what they were in the 1970s through 1990s (Feyrer *et al*. 2011, their Fig. 2), but they are higher than what occurred naturally (Figure 8-4).

The delta smelt recovery criteria in the *Recovery Plan for Sacramento-San Joaquin Delta Native Fishes* included distributional criteria based on historical catches in the Fall Midwater Trawl (FMWT) (Service 1996, p. 32). These distribution recovery criteria would have been unachievable under the near permanent low outflow conditions that were modeled for the 2008 CVP and SWP water operations consultation. If the contemporary hybrid wild-captive bred delta smelt population distributes in salinity space similarly to the historical wild population, then these criteria will remain unachievable because salinity in the western stations of the FMWT grid will be too high.

However, the more important question for the purposes of this effects analysis is whether the PA's fall flow regime will have negative effects on delta smelt, specifically if variation in fall outflow will result in a detectable change in survival of the affected life stage. The Service has previously concluded that it would (Service 2008; 2019); however, this conclusion is not supported by life cycle analysis (Table 8-9). It is possible that the Fall X2 action could have effects on small numbers of delta smelt and that the effects could have positive or negative consequences.

Based on our analysis of the PA and its predicted effects we conclude:

- Contemporary life cycle modeling supports the hypothesis that high summer outflow can contribute to beneficial effects but does not support the hypothesis that variation in fall outflow does. Life cycle models suggest that absent supplementation, delta smelt would continue to decline at rates similar to those predicted from the 2019 PA (NAA). However, one model predicts a much steeper rate of decline and was unresponsive to small variations in proposed project operations.

- The contemporary summer habitat conditions (~ June or July into September) are extremely challenging for delta smelt to survive in due mainly to the long-term accumulation of deleterious habitat change (warmer water, higher clarity water, chronically low prey density where abiotic habitat conditions are best, increasing nonnative fish relative abundance). These chronically poor habitat conditions were exacerbated by drought in the 2010s and early 2020s but are largely out of meaningful CVP and SWP operational control. Nonetheless, these chronically poor habitat conditions have had an outsized influence on the species' decline that led to its current conservation-reliant status. The lack of delta smelt detections in the EDSM for extended periods of time in the summer and fall of 2021 and again this year may have reflected temporary extirpations of delta smelt (see *Delta Smelt Supplementation* section below). The PA for June through October does not appear to meaningfully differ from a 2019 operation except in the driest June scenarios where predicted outflows may increase at times.

- Delta smelt will gain a foraging benefit from the use of the SMSCG to lower salinity in Suisun Marsh. This benefit will be unlikely prior to at least September in Dry years when the Beldon's Landing salinity target is 6 PSU.

- The anticipated foraging benefits from SMSCG operations could be partly offset by entrainment onto managed wetlands, particularly during fall flood up.

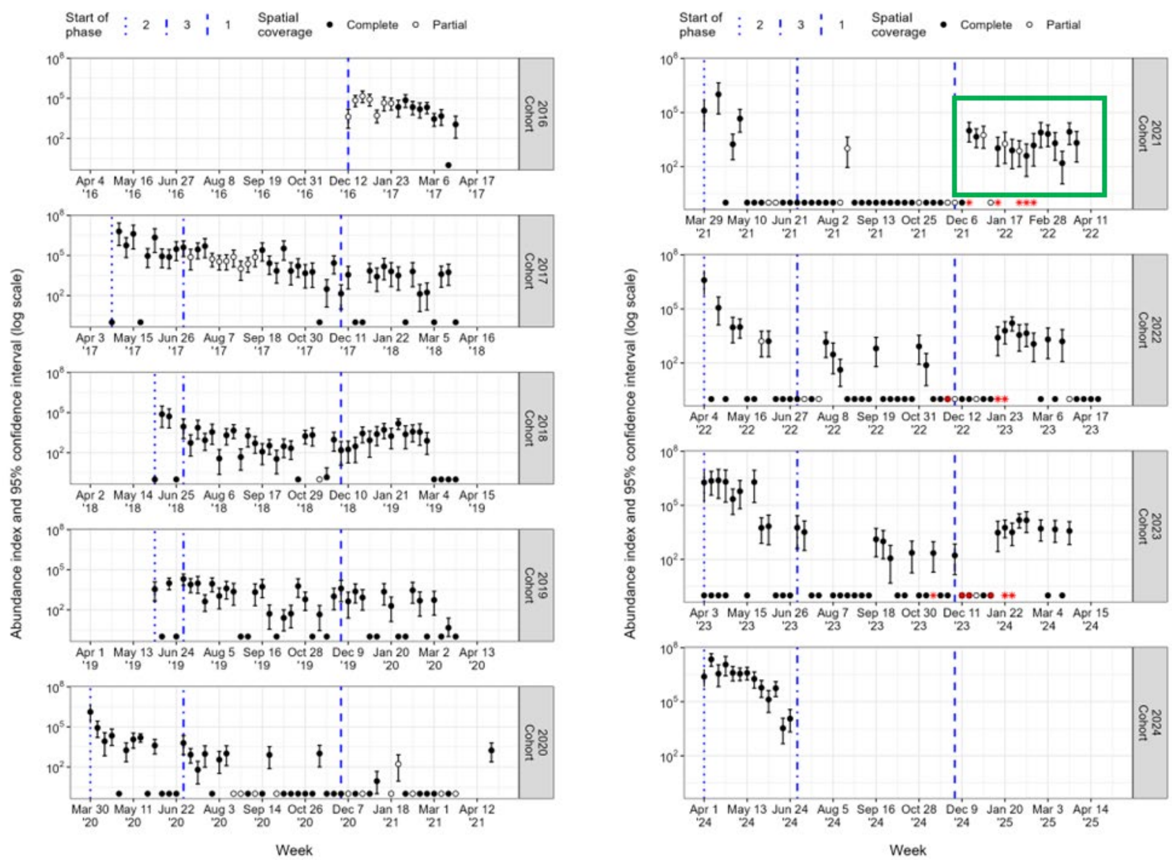
- The Fall X2 action is not anticipated to have observable effects on delta smelt survival.

- Since there may be circumstances when measurable benefits could be achieved with outflow augmentations; adaptive experimentation regarding flow pulses in the summer or fall could be helpful.

<u>Delta Smelt Supplementation</u>

Data from multiple monitoring programs including the Enhanced Delta Smelt Monitoring program (EDSM) strongly suggested that by latter 2021 the delta smelt was nearly extirpated. The EDSM had been developed and implemented to detect delta smelt at low densities (Mahardja *et al*. 2021, p. 2) but until experimental releases of delta smelt began in December 2021, only a single individual of the 2021 cohort was collected between the middle of May and the end of November (Figure 8-24). The Service and its partners responded with an effort referred to as "experimental release". This phrase was used for two reasons; one was that it was unknown whether fish grown at the U.C. Davis Fish Conservation and Culture Laboratory (FCCL) would survive when released into the wild, and the second was that the numbers initially released were too small to be considered a supplementation program. The actual numbers of fish released in each of the past three winters were 55,733 in WY2022, 43,940 in WY2023, and 91,468 in WY2024 (Service unpublished). Despite the modest numbers of fish released, the experimental release efforts by the Service and its partners likely prevented the extinction of delta smelt in the wild. However, the fundamental purpose of experimental release was to begin to experiment with practices and techniques that would be needed to guide a full-scale delta smelt supplementation program, which at least for the time being, will be needed to prevent extinction. There have been some very clear successes, and some caveats to success that must be acknowledged.

Figure 8-24: Abundance Estimates of Delta Smelt for water years 2017 into 2024. Note: data after June 2024 are not shown, but only one additional delta smelt was collected during July-October.



Reclamation proposes to continue to support development of the Delta Smelt Supplementation Program. The proposed actions related to supplementation of the delta smelt population are described in Section 3.7.10 of the BA. Reclamation and DWR will continue to work with the Service and its partners via the Culture and Supplementation of Smelt (CASS) group to implement the Delta Smelt Supplementation Strategy, which is being updated at this writing. The current and future updates of the Delta Smelt Supplementation Strategy provide the framework for activities associated with supplementation including production, tagging, transport and release of cultured fish into the wild. If feasible, production numbers will ramp up over the next few years potentially reaching 200,000 in water year 2026. Reclamation and DWR also expressed an ongoing commitment to helping the Service and CDFW continue planning for the construction of facilities that could produce 400,000 to 500,000 (200 dph) delta smelt by 2030.

Loss of delta smelt individuals will occur throughout the various action elements of the PA (*e.g.*, Delta water operations, entrainment) such that it has and will continue to have a population-level effect on the species and its subsequent generations. The primary effect of expanding the production of delta smelt and releasing them back into the estuary will be to prevent the species' extirpation. If the supplementation efforts were stopped, we expect that the species would be gone within no more than a few years, and as mentioned above, it may even be extirpated at this writing. The near-term goal of producing 400,000 to 500,000 fish for release each year is to increase the chance that FCCL will be able to collect 100 fish per year that were spawned and grew up in the estuary, to reincorporate into their broodstock. This reincorporation of wild delta smelt into the broodstock will be necessary to preserve the genetic diversity of the integrated hatchery-wild population in the long-term as there are already signs of domestication and other potentially deleterious changes in the FCCL stock (Finger *et al*. 2018, entire; Ellison *et al*. 2023, entire; La Cava *et al*. 2024, entire).

The Service (unpublished) used an updated version of LCME to estimate the probability that FCCL could expect to collect 100 fish for broodstock based on the likelihood that supplementation could return population size back to a circa 2014-2015 level (Table 8-12). At that time, FCCL staff could still reliably collect 100 individuals for broodstock with reasonable effort (≤ 5 sampling days). The simulation assumed that fish were stocked in the 'late sub-adult' life stage (~ February), a randomly chosen fraction of them between 0.25 and 0.75 would die at release, and fish that survived this initial 'cull' would co-mingle and spawn with maturing wild progeny from the previous cohort. The newly spawned fish that were predicted to survive until the following December were assumed to be potentially available to be captured in broodstock sampling. Because the modeling environment is not limited by real world constraints, annual supplementation was examined across a very large range (0 to 1 million fish per year; Table 8-12). The results suggested that if supplementation were discontinued (0 fish per year), the probability the population would return to 2014 abundance was ~ 0.08 to 0.10. The WY2024 and planned WY2025 releases are near 100,000 fish. If this level of supplementation effort were sustained the likelihood of broodstock collection success would hover around 50%. If 400,000 to 500,000 fish were stocked each year, the probability of broodstock collection success would increase to circa 75% to 78%.

Table 8-12: Life Cycle Model Projections with Levels of Supplementation

Number of pre-spawn adults stocked	Probability > 2015 nAB			
	Random covariates			2007-2016 covariates
	5 years	10 years	15 years	9 years
0	0.09	0.10	0.10	0.08
12,500	0.17	0.27	0.30	0.24
25,000	0.24	0.35	0.37	0.33
37,500	0.29	0.40	0.42	0.39
50,000	0.33	0.45	0.45	0.43
75,000	0.40	0.51	0.51	0.50
100,000	0.45	0.56	0.55	0.55
125,000	0.49	0.59	0.59	0.59
150,000	0.52	0.62	0.61	0.62
175,000	0.55	0.64	0.63	0.64
200,000	0.57	0.66	0.65	0.66
225,000	0.59	0.68	0.67	0.68
250,000	0.61	0.69	0.68	0.69
275,000	0.62	0.71	0.70	0.71
300,000	0.64	0.72	0.71	0.72
325,000	0.65	0.73	0.72	0.73
350,000	0.66	0.74	0.72	0.74
375,000	0.67	0.74	0.73	0.75
400,000	0.68	0.75	0.74	0.75
425,000	0.69	0.76	0.75	0.76
450,000	0.70	0.76	0.75	0.77
475,000	0.71	0.77	0.76	0.77
500,000	0.71	0.78	0.76	0.78
525,000	0.72	0.78	0.77	0.78
550,000	0.72	0.79	0.77	0.79
575,000	0.73	0.79	0.78	0.79
600,000	0.74	0.79	0.78	0.80
625,000	0.74	0.80	0.79	0.80
650,000	0.75	0.80	0.79	0.80
675,000	0.75	0.80	0.80	0.81
700,000	0.75	0.81	0.80	0.81
725,000	0.76	0.81	0.80	0.81
750,000	0.76	0.81	0.80	0.82
775,000	0.76	0.82	0.81	0.82
800,000	0.77	0.82	0.81	0.82
825,000	0.77	0.82	0.81	0.83
850,000	0.78	0.82	0.82	0.83
875,000	0.78	0.83	0.82	0.83
900,000	0.78	0.83	0.82	0.83
925,000	0.78	0.83	0.82	0.83
950,000	0.79	0.83	0.82	0.84
975,000	0.79	0.84	0.83	0.84
1,000,000	0.79	0.84	0.83	0.84

Various production, tagging, transport, and release strategies are currently being evaluated under the experimental release efforts and will continue to be further evaluated under the Delta Smelt Supplementation Program to understand the short-term and long-term effects on survival once released into the wild. Current information indicates the best time to release hatchery-origin delta smelt ≥200 dph is during major winter storms in the Delta and its watershed. This is because the elevated turbidity associated with first storm outflow cues a pre-spawning migration and provides cover from predators, both of which may increase reproductive success. The onset of these optimal release conditions varies from year to year and creates uncertainty in predicting idealized release schedules, which currently span from November to February. Continuing to pursue studies that evaluate post-release survival and recruitment are critical to understanding the success of the Delta Smelt Supplementation Program to offset loss of individuals from the Proposed Action. Compliance and effectiveness monitoring are important to ensure that the program accomplishments are occurring as expected, which may include using tools such as life cycle models and the more traditional in-water monitoring methodologies.

This biological opinion analyzes the Delta Smelt Supplementation Program in a framework programmatic level of analysis that will support forthcoming permit and subsequent consultation(s) on the specific effects of hatchery operations, transport, release, and tagging of delta smelt. Activities associated with future hatchery operations, transport, release, and tagging of cultured delta smelt into the wild will be addressed in one or more ESA section 10(a)(1)(A) permits and associated intra-Service section 7 consultations. In order to ensure that the future actions developed are consistent with this analysis and continue to build upon what was analyzed in this document, the Service analyzed the following Guiding Principles. The Guiding Principles are intended to follow the Delta Smelt Supplementation Strategy that is currently under development during the preparation of this biological opinion. The Guiding Principles are as follows:

- Supporting the persistence of delta smelt in the wild via supplementation of hatchery-raised fish.

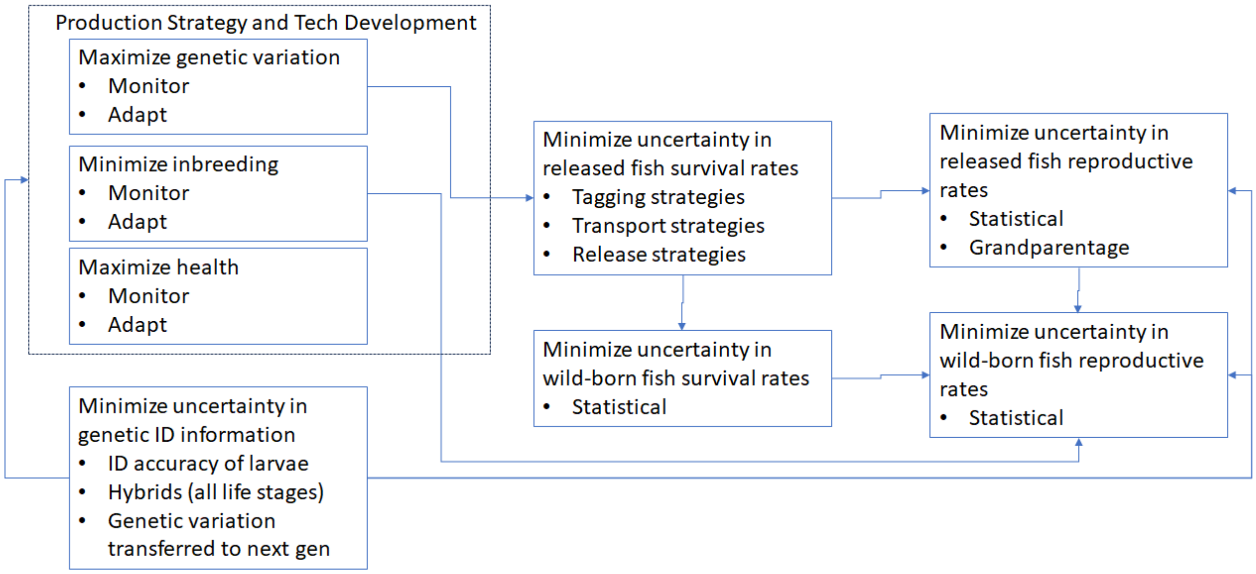
- Increasing levels of hatchery production over time under sound genetic management to improve population-levels in the wild.

- Implementing practices described in the Delta Smelt Supplementation Strategy under an adaptive management approach.

Recovery of the species through supplementation alone is impossible. In the longer-term, supplementation is anticipated to work in tandem with other conservation efforts to maintain distribution throughout the species' range and enable it to better withstand recurring droughts and the multiple other habitat factors that have led to its decline. Environmental conditions in the San Francisco Bay-Delta are the key drivers of delta smelt population dynamics as indicated by life cycle modeling efforts reviewed in the *Old and Middle River Flow Management/Seasonal Operations* and *Delta Smelt Summer-Fall Habitat Action* sections of this BiOp. However, as we have observed multiple times over the past decade, the fish appear to have very low over-summer survival.

The Service recognizes and acknowledges there is risk involved in attempting to re-establish a large fish population from a small captive, refugial one. The Delta Smelt Supplementation Program is part of the proposed Adaptive Management Plan (BA *Section 3.14* and associated appendices). This includes hatchery practices such as genetic management, transport and release, tagging approaches, and post-release monitoring and modeling. This information flow will be used to consistently improve program efficiency and efficacy (Figure 8-25). In-river monitoring methods used to capture donors will undoubtedly face limitations and uncertainties with identifying the younger life stages of delta smelt in a timely manner as depicted below in Figure 8-25. This underscores the importance of maintaining relevant statistical models that can fill information gaps and support overall management decisions.

Figure 8-25: Conceptual Depiction of Adaptive Management of Delta Smelt Supplementation.



<u>Tidal Habitat Restoration</u>

Reclamation and DWR propose to finish restoring and protecting the remainder of the 8,000 acres and an additional 396.3 acres of intertidal and associated subtidal habitat restoration in the Delta and Suisun Marsh by the year 2026. There is high scientific certainty that the restoration of more than 8,000 acres of aquatic habitat will increase the net aquatic primary production in the Delta and Suisun Marsh/Bay (Cloern *et al.* 2021, their Table 3). The location of all eleven restoration sites within the North Delta Arc helps to maximize the likelihood that delta smelt will encounter them.

Delta smelt use one part of one estuary that has been extensively monitored for decades so their habitat use is well-understood. They are predominantly affiliated with turbid, open surface water habitats in the Delta seaward into the low-salinity zone (e.g., Bever *et al.* 2016, their Fig. 4; Polansky *et al.* 2018, their Fig. 2; Hobbs *et al.* 2019, their Figs. 4-5), but have been collected in small numbers from shallow marsh habitats similar to the proposed restoration sites (Gewant and Bollens 2012, their Table 2; Williamshen *et al.* 2021, their Table S3). Small numbers of delta smelt collected from marsh edge habitats in Liberty Island were observed to have fed on a combination of their typical zooplankton prey and epibenthic invertebrates that are more affiliated with marsh habitats than open-water plankton communities (Whitley and Bollens 2014, p. 663). This was especially true in the winter and spring indicating these were larger adult and subadult fish. Diets of these older life stages have been shown to include epibenthic invertebrates and even fish larvae in newer studies as well, both adjacent to extant marsh habitats and in offshore areas (Hammock *et al.* 2017, p. 5; Hammock *et al.* 2019a, p. 863). This expansion of diet breadth in older fish partly reflects increasing size and mouth gape, which enables them to capture larger prey; however, it may also reflect a change in habitat use to maximize foraging efficiency.

We expect the utility of each restored site to vary by location and within and among years as other habitats used by delta smelt currently do (Smith and Nobriga 2023, their Fig. 5). Potential beneficial effects include added areas with elevated prey abundance or diversified foraging opportunity in or adjacent to restored sites (Hammock *et al.* 2019a, p. 863). Restoration of wetlands may enhance food supplies for pelagic fishes that enter wetlands to feed (Young *et al*. 2021 from Yelton *et al*., 2022, p. 1743). However, there is little evidence of persistent subsidies of zooplankton from tidal wetlands to open water (Dean *et al*. 2005; Mazumder *et al*. 2009; Kimmerer *et al*. 2018; Yelton *et al*., 2022, p. 1743). Food subsidy movement between wetlands and adjacent waters depends on the detailed interactions between site- and season-specific hydrodynamics and copepod behavior (Yelton *et al*., 2022, p. 1743).

Potential negative effects include the perception or realization of elevated predation risk that limits how often or how effectively delta smelt can access new foraging opportunities (Nobriga and Smith 2020, p. 16). The high potential for substantial encroachment by invasive plants is noted. As stated by Christman *et al*. (2023, p. 9):

> SAV [submerged aquatic vegetation] and FAV [floating aquatic vegetation] represent a significant management challenge for restoration of Delta habitats to benefit special-status species. Generally speaking, restoration projects provide new niche space for species and lead to an increase in non-native species cover. For example, when the Prospect Island east levee was

> breached, *Ludwigia* spp. spread rapidly and covered hundreds of acres in the restoration site [author citations omitted]. SAV has already colonized tidal marsh restoration sites throughout the Delta in varying severity (Barker Slough, Little Holland Tract, Liberty Island Conservation Bank, Decker Island, Blacklock Marsh; [author citations omitted]).

Restoration sites that are heavily encroached upon by invasive vegetation will have lower utility for delta smelt which generally avoid structured habitats, in part due to elevated risk of predation (Ferrari *et al*. 2014, their Figs. 4-5).

Primary production in tidal wetlands within the Bay-Delta estuary has been shown to support high zooplankton growth (Mueller-Solger *et al*. 2002). Tidal restoration projects in the estuary have generally created fish feeding benefits very quickly (Cohen and Bollens 2008; Howe and Simenstad 2011). Following Herbold *et al*. (2014), the restoration projects are sited and designed to locally increase food web production in places that delta smelt should be able to access it. These proposed restoration actions are therefore expected to locally enhance the food web on which delta smelt and the longfin smelt DPS depend. Restoration will be designed to increase high quality primary and secondary production in the Delta and Suisun Marsh by increasing the quality and quantity of tidal wetlands on the landscape. Tidal exchange of water between wetlands and surrounding channels is expected to distribute primary and secondary production from the wetlands to adjacent pelagic habitats where delta smelt occur and provide access to resulting prey production and transport. Tidal exchange will be optimized through the intertidal habitat restoration design by incorporating extensive tidal channels supported by appropriately sized vegetative marsh plains.

As demonstrated in Table 16 of *Section 3.7.9* of the BA, most of the acreage has been constructed or is under construction. The effects of construction of all of these projects have been addressed under separate consultations with the U.S. Army Corps of Engineers. One of the slated projects (Chipps Island) has not yet been permitted, but consultation has been initiated by the Corps on this project. Based on consultations on previous tidal habitat restoration projects, we expect that the following types of activities are likely to affect delta smelt, but this list does not include all possible effect mechanisms: vegetation removal for site preparation, access routes, construction staging, earthwork, breaching of berms or levees, new berm construction, tidal network creation, pond creation, in-water construction activities, dredging, water quality and biological monitoring, and long-term management activities. The nature and magnitude of adverse effects of tidal habitat restoration will vary depending on project design, site location, and construction timing, magnitude, and duration.

Reclamation and DWR commit to ensuring that monitoring, operation, maintenance, and permanent protection occur on these restored lands (see *Appendix A, Attachment 2: Tidal Habitat Restoration Administrative Process and Documentation Requirements* of the BA). Monitoring, management, and permanent protection of these sites (through conservation easements or other perpetual mechanisms) are important to ensure they continue to function for the benefit of the target species. The Fish Restoration Program (FRP) was established in 2012 by agreement between DWR and CDFW to implement the tidal habitat restoration requirements which began in 2008 and are carried forward in this consultation. The FRP has been monitoring the restored sites continuously since 2012, primarily focused on phyto- and zooplankton since the primary role of the restoration is to provide food web support for delta smelt. These sites are and will continue to be monitored for effectiveness of the restoration actions and will inform future actions under the proposed Adaptive Management Program considered and undertaken for the benefit of delta smelt.

Based on our analysis of the PA and its predicted effects we conclude:

- The balance of beneficial effects and negative effects of restoration on delta smelt will vary among restored sites;

- The balance of beneficial effects and negative effects of restoration on delta smelt will vary over time (seasonally and inter-annually); and

- The proposed Adaptive Management Program (BA *Section 3.14*) can be used to inform efforts to maximize benefits and minimize negative effects based on on-going effectiveness monitoring.

Sites Reservoir and Delta Conveyance Projects

Reclamation (for Sites Reservoir) and the U.S. Army Corps of Engineers (for Delta Conveyance Project [DCP]) propose to initiate separate section 7 consultations for the non-operational construction and maintenance components of these projects. Effects from construction and maintenance will be addressed in those separate consultations, but for context, there will be no effects to delta smelt that would be caused by the construction of Sites Reservoir because its proposed location is well to the north of this species' distribution limits. The Service would anticipate some effects to these fish from construction of the DCP, particularly the in-water construction activities along the Sacramento River. The proposed location of the DCP intakes is near the typical northern limit for delta smelt (Merz *et al*. 2011, their Figs. 2 and 6).

Construction of the DCP intakes is likely to affect individuals from pile-driving noise, elevated predation from in-water disturbance or artificial lighting, trapping behind coffer dams, collection associated with fish salvage operations behind coffer dams or other fish sampling in the vicinity associated with construction-related monitoring, accidental chemical spills, etc. In general, open-water fishes are very capable of avoiding being crushed by falling objects or construction equipment in the water so long as they have space to move around in. The pressure waves and water displacement caused by these kinds of activities are readily detected by shoaling fish, so the Service considers effects from that kind of activity to be unlikely unless the fish are already in a confined space due to other construction activities.

A framework programmatic approach was proposed to address the effects of operations of the Sites Reservoir and DCP. The process for this type of consultation is described in the *Consultation Approach* section of this BiOp. Some project elements and their effects on listed species or critical habitat are likely to change as the proposed action for these new infrastructure projects is developed. As described in *Section 3.15* of the BA, Reclamation will initiate future consultations to address the near-field and far-field effects of operations of both Sites Reservoir and new water conveyance facilities in the North Delta and at that time, they will provide sufficient information to support the site-specific analysis of these projects.

The fundamental role of these projects is to increase the climate resilience of California's water supply and delivery systems by increasing the operational flexibility of the CVP and SWP (BA *Section 3.15.5* and *Tables 3-16* and *3-17*). The Sites Reservoir would be located in currently unincorporated areas of Glenn and Colusa counties west of the community of Maxwell (BA *Section 3.15.3*). The planned reservoir could store up to 1.5 million acre-feet (MAF) of water. It will be filled opportunistically at variable rates with a maximum rate of about 4,200 cfs. Water to fill Sites Reservoir will be diverted off the Sacramento River at two existing facilities, one at Red Bluff and the other at Hamilton City. Water released from the reservoir could be released into the Yolo Bypass or the Sacramento River using existing canals, or into the Sacramento River via a new proposed canal near the town of Dunnigan. Currently, Sites Reservoir has 22 planning partners that would receive water supplies from the reservoir. Reclamation is one of them as is the California Water Commission. The California Water Commission is a nine-member entity appointed by the Governor and confirmed by the State Senate to advise DWR and approve any rules and regulations promulgated by DWR (https://water.ca.gov/cwchome).

The DCP would involve a new water diversion facility on the Sacramento River near the town of Hood (BA *Section 3.15.7.2*). A maximum of 6,000 cfs of diverted water would be routed via an underground tunnel to the existing SWP facilities in the South Delta where it could subsequently be delivered to SWP contractors. The number of diversions and tunnels is lower than what was proposed in the California WaterFix (Service 2016). As such, the maximum diversion rate is also lower and the proposed positive barrier fish screen surface areas are much smaller. It is reasonable to expect that there will be some high flow conditions under which both projects could be simultaneously operating at maximum capacity to collectively divert about 10,000 cfs from the Sacramento River.

How these projects will result in changes to flow into and through the Delta, and effects to delta smelt that would result from those changes will be addressed in subsequent consultation and through future modeling of both projects combined with LTO.

Guiding principles and conservation measures

Reclamation and DWR propose a framework in the BA that includes a suite of guiding principles to avoid, minimize and offset adverse effects of Sites Reservoir and Delta Conveyance to listed species and critical habitat. As described in *Section 3.15.8* of the BA, these principles may be adjusted or refined in the future. Reclamation and DWR propose principles for different regions of the system, including Upper Sacramento River (Sites only), Sacramento River from Red Bluff Pumping Plant to Knights Landing (Sites Only), and Below Knights Landing and in the Delta.

Both of these new proposed infrastructure projects will have adaptive management programs that will integrate with the LTO Adaptive Management Program as described in *Section 3.14* of the BA. The DCP adaptive management and monitoring program would be used to evaluate and consider changes in operational criteria, if necessary, based on information gained before and after the new facilities become operational. This program would be used to consider and address scientific uncertainty and clarify policy choices regarding the Delta ecosystem and potential effects of the project. In addition, an adaptive management and monitoring plan would be prepared for each mitigation site to help ensure habitat creation goals are met. (*Section 3.18, DCP Public Draft EIR*). For Sites, criteria may be refined in actual project operations through adaptive management and in coordination with the fisheries agencies.

Reclamation and DWR propose general adaptive management principles (*Section 3.15.9* of the BA). These principles generally describe monitoring objectives, studies to inform operational modifications to minimize effects, integration with the LTO Adaptive

Management Program, and a commitment to applying adaptive management concepts to mitigation plan design. Specific adaptive management studies were not proposed in this consultation; therefore, none are analyzed.

Guiding principles of operational criteria in the Delta are outlined in *Section 3.15.8.3* of the BA. These principles include the commitment to monitor and mitigate the effects of water diversions of Delta aquatic species, including delta smelt. This includes further habitat restoration to mitigate the effects of the projects. Specific criteria, such as amount, location, or restoration design is not yet developed, but will be coordinated with the Service, NMFS, and CDFW once more information is known about the nature and extent of these effects. Further coordination on the restoration necessary to minimize or offset the effects of these projects on delta smelt will be incorporated into the analyses in the subsequent consultations. Specific conservation measures, including compensatory mitigation, have not yet been developed for both projects. Reclamation and DWR propose to develop these measures prior to operations implementation; therefore, these measures will inform the subsequent consultations for both of these projects.

Quantitative Analysis

There is preliminary quantitative modeling of how Sites Reservoir and DCP may be operated once they are online circa 2033 (Sites; not specified for DCP in the PA – see BA Section 3.15.7). There are also some specific proposed operating criteria for both facilities in the BA (Tables 3-18 and 3-19). However, due to the framework programmatic nature of this consultation, the Service is treating these as conceptual constructs, not proposed operations.

Reclamation and DWR propose to model both of these projects to inform the subsequent consultations. This modeling will be combined and will utilize LTO conditions and criteria as the baseline in order to provide a comprehensive assessment of how operations of these projects are likely to influence the hydrodynamics in the system. This modeling will then be incorporated into a quantitative effects analysis which will focus on key indicators of biological/ecological relevance such as storage, flows, and temperatures at key locations on the Sacramento River, as well as through and downstream of the Delta. The intent is to utilize the proposed operational criteria in the quantitative analysis with the recognition that potential operational refinements will be informed by the programmatic analysis, which will guide subsequent project-level consultations. Adaptive Management is intended to further address outstanding uncertainties up to, and throughout, the operations phase. Implementation goals are included to provide the necessary level of information to inform the subsequent consultations. Since this quantitative information is not yet available, effects to delta smelt and delta smelt critical habitat are not addressed in this BiOp, but will be addressed in the subsequent consultations.

The diversion of Sacramento River water into Sites Reservoir and release of water from it would not in and of themselves have effects on delta smelt. The operational effects of Sites Reservoir will depend on the details of how it integrates with existing CVP and SWP facilities and the proposed DCP. The same is largely true of the DCP but operation of the North Delta diversions is likely to have direct effects stemming from entrainment and impingement. Based on this species' historical distribution we expect these impacts to be small relative to exporting water from the South Delta.

Beyond that, the proposed expanded CVP and SWP hydro-system has 3 possible qualitative outcomes depending on how it is operated: delta smelt status improves, stays the same, or worsens.

Future considerations

The framework proposed by Reclamation and DWR includes the recognition that there are future regulatory processes and considerations that will influence the initial proposed operational criteria and other aspects of both projects. It will be several years before these projects are constructed and become operational. *Section 3.15.1* of the BA outlines foreseeable processes that are ongoing or not yet begun which may result in changes to either or both projects. Results of these processes, including any changes to operational criteria, will be incorporated into the analysis (including quantitative modeling, as necessary) supporting the subsequent consultation processes. In addition, changes to the status and environmental baseline of delta smelt and delta smelt critical habitat will need to be incorporated into future analyses (including quantitative modeling, as necessary). The effects of climate change, delta smelt supplementation, and other factors that are likely to influence the status and baseline of this species will be addressed as well. All of these factors support a framework programmatic approach for both the Sites Reservoir and Delta Conveyance projects.

Adaptive Management

Some of the Adaptive Management Actions (AMAs) are not anticipated to result in activities that may affect listed or proposed species or critical habitat. For instance, actions that only entail database or model development and interpretation; operations that entail modifications (such as timing or magnitude of pulse flows) that are not expected to affect implementation of operational measures designed to avoid or minimize impacts to USFWS jurisdictional species; and monitoring or studies in areas where listed species under USFWS jurisdiction are not expected to be present or otherwise affected.

AMAs that may affect listed species or critical habitat include:

- Summer-fall habitat action for delta smelt
- Efficacy of Suisun Marsh Salinity Control Gate operations
- Experimental Food Enhancement Actions
- Tidal Habitat Restoration Effectiveness
- Longfin Smelt Science Plan Actions
- Delta Smelt Supplementation
- Spring Delta Outflow

See the attached Effects Tracking Table for the species and critical habitat that may be affected by each AMA. Note that these AMAs are also described in the Special Studies section of the BA. The following effects analysis is applicable for both the Adaptive Management and Species Studies sections.

Some of the effects of these AMAs are addressed in separate consultations or permits. In those instances, those separate documents and what they cover are described in the Environmental Baseline section. This BiOp addresses the remainder of effects that are reasonably certain to occur as a result of implementation of the above AMAs. These effects are incorporated as a stand-alone programmatic consultation, as described in the *Consultation Approach* section.

Summer-Fall Habitat Action for Delta Smelt

The PA includes two types of actions intended to study habitat effects on delta smelt survival and evaluate effectiveness of mitigation actions in improving habitat and food availability. The Delta Coordination Group (DCG) is the Adaptive Management Team (AMT) identified to develop the science and monitoring plan for these summer-fall habitat studies and synthesize information to determine if recommendations for management changes are necessary.

The first type of action entails studying the operations of the SMSCG to maximize the number of low salinity days at Belden's Landing to maximize suitable habitat available to delta smelt in Suisun Marsh and Grizzly Bay. The DCG has already assessed this type of action and would consider this information in determining if management changes are needed. The second type of action entails experimental food subsidies to increase localized prey availability for delta smelt in the North Delta and Suisun Marsh, resulting in opportunities for higher growth and survival of juvenile and sub-adult life stages. Food actions include North Delta Food Subsidy Action, Managed Wetland reoperation in Suisun Marsh, and Sacramento Deepwater Ship Channel Food Subsidy Action. There was no information provided in the BA about how or if additional water would be needed to be made available to support either of these actions; therefore, it is too speculative at this time to determine if there will be effects to any listed species or critical habitat from making additional water available. This information will be provided to the Service pursuant to the stand-alone programmatic process described in the *Consultation Approach* section of this BiOp.

Both types of actions are intended to benefit delta smelt during the summer and fall by making small but sustainable improvements to habitat including food availability. Through the DCG, studies associated with these actions are expected to improve our understanding of the efficacy of these actions while minimizing effects to delta smelt. In order to understand if these actions are benefiting this species, it is possible that it may be necessary to capture delta smelt in the study area and examine their body condition. It is also possible that other biotic (such as food resources) and abiotic (such as turbidity and salinity) monitoring in the study area may be necessary to better understand what impact these actions are having on habitat. The number of delta smelt exposed to these actions is expected to be low and evaluated carefully by the DCG or other appropriate oversight groups like the Interagency Ecological Program (IEP).

Tidal Habitat Restoration Effectiveness

Most of the tidal habitat restoration identified in Section 3.7.9 of the PA is constructed or under construction. In order to fulfill its intended two-fold purpose to enhance food production and provide rearing habitat for delta smelt, habitat management and monitoring has been and will continue to be implemented and evaluated on a regular basis. Habitat management may include treatment or clearing of invasive vegetation, which could injure or kill delta smelt in the vicinity of the management activities. These effects will be minimized by the AMT's assessment and planning process. Overall, removal of invasive vegetation is expected to benefit delta smelt by improving habitat quality, but the sustainability of removal actions needs further evaluation. Monitoring and shorter-term studies will allow better assessment of the biotic and abiotic capacity of restored tidal wetlands to support delta smelt. This is the continuation of ongoing monitoring that historically has captured or otherwise detected very few delta smelt. It is possible the rate of capture could increase as production and release associated with the Delta Smelt

Supplementation Program increases; however, this would still likely represent a small proportion of the total population and could be an indication that delta smelt are utilizing and benefiting from the habitat restoration. The net export of food web components or contributors from established and managed sites relative to occupied smelt habitats is likely also to be a central component of effectiveness monitoring. This information will be synthesized to inform future recommendations for improving restoration sites' ability to produce food for delta smelt or refining concepts of what is and is not delta smelt habitat.

Longfin Smelt Science Plan Actions

There are seven science priority areas identified in the Longfin Smelt Science Plan: (1) Life cycle modeling; (2) Factors affecting abundance, growth, and survival; (3) Improved distribution monitoring; (4) Improved larval entrainment monitoring; (5) Longfin Smelt culture; (6) Fish migration and movements; and (7) Spawning and rearing habitats for Longfin Smelt. The life cycle model will guide implementation of the plan, particularly with respect to new and expanded monitoring. Even though this plan is geared toward the longfin smelt DPS, given the overlap in their range, some of the actions proposed to be implemented are likely to affect delta smelt.

As described in the *Environmental Baseline* section of this BiOp and the Monitoring section of the PA (Section 3.10 of the BA), there are existing consultations that may be utilized to address the effects of new and expanded monitoring. If the effects are different from these existing consultations, Reclamation will initiate consultation consistent with the framework programmatic approach described in Section 3.10 of the BA. Following the principles of this framework will ensure this monitoring will be scientifically robust and improve overall operations of the CVP and SWP, while minimizing effects to delta smelt.

Delta smelt Supplementation

Reclamation proposes to continue to support development of the Delta Smelt Supplementation Program, including capturing existing genetic diversity, maximizing numbers of delta smelt produced in captivity, and to begin supplementation of the wild population. New findings from the supplementation program will be developed and the supplementation strategy will be periodically updated to guide production targets and methods development. A process to evaluate production targets to support supplementation will be developed and revisions of production numbers, timeline, release methods, monitoring, and genetic management strategies may be necessary. New or revised monitoring to support the Delta Smelt Supplementation Program will be subject to the adaptive management governance process and will either utilize existing consultations or be addressed under the framework programmatic approach in *Section 3.10* of the BA.

Spring Delta Outflow

A multi-year evaluation of the performance of increased spring Delta outflows will be conducted to inform the next iteration of the LTO consultation. A draft science plan for the HRL program outlines a framework for assessment variables to determine how to deploy the proposed outflow to maximize benefits to target species, including delta smelt. Assessment could include biotic and abiotic monitoring to inform performance and future decisions regarding deployment. Through the AMT and HRL governance processes, effects to delta smelt are expected to be minimized. It is possible that actions to make the water available for outflow may affect species or critical habitat, such as changes to amount or timing of diversions that would have otherwise been used to cultivate rice which is utilized by giant garter snakes. However, there was not enough specific information provided in the BA about what actions would occur to make additional water available to support the spring delta outflow action; therefore, it is too speculative at this time to determine if there will be effects to any listed species or critical habitat from making additional water available. This information will be provided to the Service pursuant to the stand-alone programmatic process described in the Consultation Approach section of this BiOp.

d. Effects of the Action on Critical Habitat

Background

Critical habitat is defined in section 3(5)(A)(i) as "the specific areas within the geographical area occupied by the species, at the time it is listed in accordance with the provisions of section 4 of this Act, on which are found those physical biological features (I) essential to the conservation of the species and (II) which may require special management considerations or protection." At the time of delta smelt's critical habitat designation in 1994, the features were referred to as Primary Constituent Elements (PCEs). The Service's primary objective in designating critical habitat was to identify the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. The intended conservation value of delta smelt critical habitat is to consistently provide all of the needed habitat attributes corresponding to where delta smelt reside during their life cycle. In addition, the habitat attributes must be of a sufficient quantity and quality to support growth, survival, and reproduction.

The Service (1994) defined four PCEs for delta smelt critical habitat: 1) physical habitat, 2) water, 3) river flow, and 4) salinity. Each PCE is reviewed in detail in the *Status of Critical Habitat*. Due to the interrelationship between the PCEs and the intended conservation role they serve for different delta smelt life stages, some effects of the PA are similar and overlap across the PCEs. For instance, Delta outflow determines the extent and location of the low-salinity zone and in so doing influences the areas of physical habitat delta smelt utilize at all times of year. Therefore, many of the effects described below for the PCEs are difficult to separate and are repeated for multiple PCEs. Further, the scientific understanding of delta smelt and its habitat has progressed in the intervening 30 years reinforcing some of the assumptions that underlie PCEs and limiting the ongoing utility of others. Service (2019) updated our conceptual understanding of the PCEs according to the state of science as it existed in circa 2018 or 2019, but relevant publications on delta smelt and aspects of its critical habitat have continued to rapidly increase.

As described in the *Status of Critical Habitat* section, critical habitat is currently not serving its intended conservation role and function for all life stages. The Service's review indicates it is rearing habitat that remains most impacted by ecological changes in the estuary, both before and since the delta smelt's listing under the Act. Those changes have stemmed from chronic low outflow, changes in the seasonal timing of Delta inflow, lower flow variability, species invasions and associated changes in how the upper estuary food web functions, declining prey availability, high water temperatures, declining water turbidity, and localized contaminant exposure to delta smelt.

Effects of the PA to each PCE were evaluated qualitatively and, when appropriate, using CalSim 3 modeling. The CalSim 3 model is used by Reclamation and DWR to simulate the operation of the major CVP and SWP water facilities in the Central Valley and generates monthly estimates of river flows, exports, reservoir storage, deliveries, and other parameters (see *Modeling of the Proposed Action*). The hydrologic modeling of Alternative 2 most closely represents the PA, and its hydrologic modeling outputs have been used to evaluate the effects of water operations on critical habitat. Alternative 2 includes four scenarios which are described in BA (BA *Appendix F-Modeling*). Additionally, the Service qualitatively evaluated the effects of operational and non-operational components of the PA to delta smelt critical habitat which were not included in the modeling (e.g., the Summer-Fall Habitat Action and Experimental Food Enhancement Actions). Tables 8-13 and 8-14 summarize where the effects to critical habitat from the PA are expected to occur for each PCE and delta smelt life stage.

Similar to the species-level effects analysis above, any effects to delta smelt critical habitat of operation of the Tracy Fish Collection Facility (BA Sections 3.7.3, 3.7.7 and 3.7.7.1), Skinner Fish Protection Facility (BA Sections 3.7.8, 3.7.8.1, and 3.7.8.2), the Clifton Court Aquatic Weed Management (BA Section 3.7.14), Agricultural Barriers (BA Section 3.7.12), B.F Sisk Dam Raise and Reservoir Expansion Project (BA Section 3.7.15), and Contra Costa Water District Rock Slough Intake operations are encompassed in the evaluation below and are not evaluated further.

<u>All Life Stages of Delta Smelt: Effects to PCE 2-Water</u>

According to the BA, with respect to PCE 2-Water, relative to the NAA, reduced winter-spring inflow to the Delta under the PA may reduce sediment supply, and therefore turbidity during winter-spring, as well as during summer/fall when resuspension of sediment supplied in the winter/spring is important to the suitability of rearing habitats.

The BA (Section 9.3) also indicates that the PA will cause small changes in two components of water quality (PCE 2), sediment load and food availability, needed to support delta smelt in all life stages, but such changes will have small to negligible effects compared to the baseline conditions, either for the component alone, or in combination with actions proposed as part of the PA.

*Sediment load***:** Turbidity produced by sediment suspended from the erodible sediment pool in the estuary by wind, river flow and tidal forces can contribute to cover for delta smelt needed to avoid predators and to facilitate successful feeding and predator avoidance by the larvae (Ferrari *et al.* 2014; Hasenbein *et al.* 2016; Schreier *et al*. 2016). While suspended phytoplankton can also contribute to turbidity, the estuarine turbidity maximum can be influenced by the available sediment pool (Schoellhamer 2011). Currently, available science does not permit us to extrapolate turbidity concentrations from sediment load.

The majority of suspended sediment entering the estuary comes from the Sacramento River and Yolo Bypass during high flows in winter and spring with a smaller proportion coming from the San Joaquin River at Vernalis and the Eastside tributaries. Previous studies have estimated that about 2% of the sediment discharge at Freeport was exported via the SWP (Schoellhamer *et al.* 2012). OMR Management actions will work to prevent the draw of sediment-laden Sacramento River water into the central Delta thus minimizing the volume of sediment export. Based on our understanding of sediment transport timing and sources in the estuary, any changes resulting from the PA are expected to be negligible.

The PA includes two components, Sites Reservoir and the DCP, which are being addressed by a framework programmatic approach. The Sites Reservoir (BA *Section 3.15*) and DCP are expected to alter sediment transport in the Sacramento River. Sites is proposed as a 1.5 MAF off-stream surface water reservoir. Sites will entrain turbid Sacramento River water, settle the sediment load into the reservoir, and release less turbid water back into the river at a later time. The DCP is a proposed in-river intake and conveyance facility in the North Delta on the Sacramento River to convey water to the CVP and SWP. The DCP will export sediment-laden Sacramento River water out of the estuary and into constructed settling basins and then into the conveyance and forebay. The effects of the operations of these two projects on available sediment supply to the Delta from the Sacramento River is unknown at this time but will be evaluated during their subsequent consultations under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp and consistent with the framework described in Section 3.15 of the BA.

Food availability: Primary production in the estuary varies annually due to several factors including consumption by the invasive overbite clam, a long-term decline in total suspended solids, nutrient inputs, and river flow (Jassby *et al.* 2002). Water exports directly entrain phytoplankton and zooplankton (Jassby and Cloern 2000). No estimates of food web loss to entrainment were provided in the BA. Modeling by Kimmerer *et al.* (2019) suggests that exports do not affect the subsidy of the copepod, *P. forbesi*, to the low-salinity zone in summer and fall during juvenile rearing. Thus, although zooplankton productivity might be higher if there were no exports, we do not expect that the rate that *P. forbesi* exchanged between freshwater and the low-salinity zone will be affected.

It is logical to expect some changes in available phytoplankton and zooplankton resulting from Sites Reservoir and DCP operations. Sacramento River water entrained into Sites Reservoir, once released back, may carry increased primary productivity due to increased water residence time in reservoir storage. The DCP is expected to export Sacramento River productivity out of the estuary and into the water projects. The individual and net effects of the operations of these two components of the PA are unknown at this time but, consistent with the framework described in section 3.15 of the BA, will be evaluated during their subsequent consultations.

The PA includes Tidal Habitat Restoration, and Adaptive Management actions which may augment delta smelt's food supply and/or provide information for food web management.

Tidal Habitat Restoration: Reclamation and DWR have proposed to complete construction and protection of the remainder of the 8,000 acres and an additional 396.3 acres of intertidal and associated subtidal habitat in the Delta and Suisun Marsh by 2026 to increase estuary productivity including the availability of delta smelt prey. There is high scientific certainty that the restoration of more than 8,000 acres of aquatic habitat will increase the net aquatic primary production in the Delta and Suisun Marsh/Bay (Cloern *et al*. 2021, their Table 3). Primary production in tidal wetlands within the Bay Delta estuary have been shown to support high zooplankton growth (Mueller-Solger *et al*. 2002). These proposed restoration actions are therefore expected to enhance the food web on which delta smelt depend. Restoration will be designed to increase high quality primary and secondary production in the Delta and Suisun Marsh increasing the quality and quantity of tidal wetlands on the landscape. Tidal exchange of water between wetlands and surrounding channels is expected to distribute primary and secondary production from the wetlands to adjacent pelagic habitats. Delta smelt critical habitat is estimated to encompass between 60,000 and 65,000 acres. The PA includes a total of 8,396 acres of freshwater tidal habitat restoration which, once completed, may potentially result in a 13% to 14% increase in the amount of aquatic habitat within delta smelt critical habitat contributing to primary and secondary aquatic productivity for all delta smelt life stages. However, the magnitude of the effect of this component of the PA is unknown at this time.

Reclamation and DWR commit to ensuring that monitoring, operation, maintenance, and permanent protection occur on these restored lands. The monitoring program will evaluate the effectiveness of the restoration actions. DWR has established the FRP, a coordinated effort between DWR and CDFW, which focuses on the planning, design, and permitting of individual restoration projects. In addition, the Fishery Agency Strategy Team (FAST), which includes Reclamation, CDFW, NMFS, and the Service, coordinates on the design and crediting of proposed restoration projects to ensure they meet the objective stated above. Since this activity is being addressed programmatically in this consultation, further detail about effects including benefits to delta smelt critical habitat have already been addressed in project-specific consultations or will be addressed in subsequent consultation consistent with the framework described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp prior to implementation.

Adaptive Management: The PA includes an adaptive management program designed to inform the long-term operations of the CVP and SWP using a structured analytic-based approach. Implementation of the program will entail additional monitoring and research to carry out elements of the program under the direction of a steering committee. The actions under the program are categorized into bins correlated with their anticipated timeframe for their completion and possible implementation into decision-making tools or in some cases, as future actions. A full description of the purposes and scope of the program, governance structure, decision-making process, and initial list of actions are incorporated by reference from Section 3.14 of the PA and the adaptive management appendices from the BA.

Some of the Adaptive Management Actions (AMAs) are anticipated to result in activities that may affect delta smelt PCE 2 for all life stages. They include the Summer-Fall Habitat Action for delta smelt and Experimental Food Enhancement Actions in areas including Suisun Marsh and the Sacramento Deepwater Ship Channel.

The PA will cause small changes in several components of water quality (PCE 2) needed to support delta smelt in all life stages. The benefits to water quality of Tidal Habitat Restoration, Adaptive Management Program, and Spring Delta Outflow may help provide the needed habitat attributes in appropriate areas where delta smelt reside, particularly for rearing juvenile delta smelt. These benefits to delta smelt will depend on how and when these actions are implemented, and if other necessary habitat attributes are also present and of sufficient quality to support completion of the life cycle. Effects of the framework programmatic components (tidal habitat restoration, Sites Reservoir operations, DCP operations), including how these components contribute to water quality, have been addressed in project-specific consultations or will be addressed in more detail, consistent with the framework described in section 3.15 of the BA, in subsequent consultation on these components.

Table 8--13: Summary of Effects of the PA on Critical Habitat for Adult Delta Smelt as compared to the NAA.

Life stage	*PCE 1: Physical habitat*	*PCE 2: Water [quality]*	*PCE 3: River flow*	*PCE 4: Salinity [*low-salinity zone*]*
Migrating adults *(Dec-March)*	Not Applicable	Negligible loss of sediment due to exports. Small contributions to prey production from restoration in unknown locations in the Delta and Suisun Marsh.	OMR flows are similar compared to the NAA. OMR Management actions will result in reduced entrainment risk. Spring Outflow, may improve flow conditions reducing entrainment risk if implemented for adults in March	No change in effect
Spawning adults *(Feb-May)*	No change in effect	Negligible loss of sediment due to exports. Small contributions to food web from restoration in North Delta Arc and Suisun.	Spring outflow, if implemented, may result in reduced entrainment risk if implemented in April and May.	No change in effect

Table 8--14: Summary of Effects of the PA on Critical Habitat for Larvae and Juvenile Delta Smelt as compared to the NAA.

Life stage	*PCE 1: Physical habitat*	*PCE 2: Water [quality]*	*PCE 3: River flow*	*PCE 4: Salinity [*low-salinity zone*]*
Migrating larvae and juveniles *(March-June)*	Not Applicable	Negligible loss of sediment due to exports. Small contributions to food web from restoration in North Delta Arc and Suisun.	OMR flows are similar compared to the NAA.	No change in effect
Rearing larvae and juveniles *(July-Dec)*	Not Applicable	Negligible loss of sediment due to exports. Small contributions to food web from restoration and potentially food web enhancement action in unknown locations in the North Delta Arc and Suisun.	Rearing conditions in the NAA are poor. Adaptive Management actions including the Summer-Fall Habitat Action. particularly in Suisun, will improve conditions in Above Normal, Below Normal, and Normal years relative to the NAA.	Rearing conditions in the NAA are poor. Adaptive Management actions including the Summer-Fall Habitat Action. particularly in Suisun, will improve conditions in Above Normal and Below Normal water years relative to the NAA.

Effects to Delta Smelt Critical Habitat by Life Stage

Habitat conditions supporting larval and juvenile transport

PCE 3 – River Flow

The operation of the CVP and SWP involves the storage, release, and diversion of freshwater. Stored water is delivered to the Delta where some of it is exported, often along with runoff from other sources. These actions directly influence river flows in the Delta and Suisun Bay, which in turn affects aspects of habitat quality within the critical habitat boundaries (Service 1994; Bever *et al*. 2016). The PA provides a quantitatively modeled base condition and qualitative descriptions of real-time and seasonal management strategies that will be used to modify the modeled base condition to various degrees. The PA is expected to result in small adverse effects to this PCE related to larval and juvenile transport (BA Section 9.3.3).

It was once thought that delta smelt needed to be transported from "upstream" spawning habitats to "downstream" rearing habitats from December through July (Service 1994). Now we recognize most of the larval transport occurs from March through June. Delta smelt can likely begin feeding where they are hatched, and often rear close to where they are believed to have hatched. It is also recognized that larval fishes, including delta smelt, use swimming behavior changes timed to the tidal cycle and local bathymetry to maintain themselves in low-salinity habitats that often have large seaward net flows (Bennett *et al*. 2002). The primary remaining mechanism related to a flow for larvae and juveniles that is thought to be both pertinent to the critical habitat function, and under substantial CVP and SWP control, is the varying magnitudes of flood and ebb tidal flows in Old and Middle rivers that are indexed by OMR. The more negative the OMR flow, the greater the flood tide volume and velocity toward the South Delta pumping plants are relative to the ebb tide, and the more Sacramento River water back-fills for the diverted San Joaquin/South Delta water. This tidal asymmetry indexed by OMR can be associated with net southward transport of larval delta smelt into unsuitable habitat and ultimately into water diversions where they may be salvaged and have an extremely low likelihood of survival (Kimmerer 2008; 2011).

The CalSim 3 modeling in support of the PA caps OMR flow at -5000 cfs (14-day moving average) during March-May (except during any Storm Flex actions that may begin in February but extend into March). The BA (Section 9.3.3) states that the PA will result in diversions of water that may increase entrainment risk. The PA also includes OMR management actions to reduce entrainment of larval and juvenile delta smelt (Sections 3.7 through 3.9). The Service expects that the actions in the PA will result in water operations with similar impacts that led to the baseline condition and, after taking into account the current status as a conservation-reliant species that experiences temporary extirpations every year, that will continue to act on the species in a similar manner for the larval transport river flow PCE.

The PA also includes a Spring Delta Outflow component which proposes augmentation of outflow during March through May for two years through export reductions, and beyond two years if the SWRCB HRL program is approved and the parties execute or are in the process of executing the agreements. If implemented, the Delta could receive between 150-826 additional TAF, depending on water year type, that would improve flows during the larval and juvenile transport period.

Habitat conditions supporting rearing

PCE 4 – Salinity

The salinity of the estuary plays a key role in determining how delta smelt habitat attributes overlap (see *Status of Critical Habitat*). The low-salinity zone expands and moves downstream when river flows are high (Jassby *et al*. 1995; Kimmerer *et al*. 2013; MacWilliams *et al*. 2015). By exporting river inflows (PCE 3), the PA can contribute to upstream movement and contraction of the low-salinity zone (PCE 4) into the Delta shipping channels, which can in turn affect how PCE 4 interacts with the other three PCEs. Ideal rearing conditions for juvenile delta smelt occur when the location of the low-salinity zone maximizes habitat quantity and quality by providing appropriate salinity, turbidity, water quality, temperature, and food availability. The location of the low-salinity zone within the estuary is important in determining the quality, for both extent and suitability, of juvenile rearing habitat. When X2 is at 81 km or above, the upstream extent of the low-salinity zone differs between the Sacramento and San Joaquin rivers. However, the portion of the low-salinity zone that extends up the San Joaquin River in summer and fall is poor quality due to SAV, high water clarity and elevated temperature. Therefore, the Service uses X2 on the Sacramento River (Hutton *et al*. 2016) as the habitat indicator. When X2 is located at or above 85 km, the entire low-salinity zone is upstream of Chipps Island, east of the turbid shoals in Suisun Bay (i.e., Grizzly Bay and Honker Bay) and the more suitable habitat conditions that occur when the low-salinity zone overlaps these embayments (Bever *et al*. 2016). Figures 8-26 and 8-27 shows the predicted difference in expanse and location of the low-salinity zone under steady-state Delta outflow conditions when X2 is located at 84 km versus 85 km.

The PA modeling (BA Appendix F, Tables F.2.6-1-2b through F.2.6-1-5c) provides predicted monthly average X2 position and X2 exceedance statistics for the NAA and each scenario of Alternative 2. These tables also include the predicted differences in X2 between the NAA and each Alternative 2 scenario for all months and by water year type. The NAA includes an average X2 position of 85 for the months of August, September, October, and November. There were no differences in average predicted X2 position for any of the Alternative 2 scenarios and the NAA during the rearing period (June-December).

Despite the similarity between the PA and the NAA, it is important to note the baseline condition of rearing habitat in the Estuary. Figure 8-28 shows the number of months that X2 is predicted to be at or above 85 km for the NAA and PA scenarios. Although slightly improved under the PA, in November X2 is above 85 km 95% of the time under all scenarios.

Historically, under D-1641, DWR operated the SMSCG to lower the salinity within Montezuma Slough and Suisun Marsh from October through May. The frequency of SMSCG operations were a function of outflow. When outflow was low in the fall through the spring, the gates are operated more frequently to pump fresh water into the marsh. In wetter years, operations could be limited to a few days during the driest parts of the year. Historical operation of the gates consistent with D-1641 only slightly overlaps with the proposed Summer-Fall Habitat Action which includes up to an additional 60 days of gate operation from June through October. SMSCG operation moves low salinity water into Montezuma Slough which is in turn directed into Suisun Marsh via the RRDS and other intakes. The operation of the SMSCG is expected to improve salinity conditions experienced by delta smelt inhabiting Suisun Marsh and attract additional delta smelt into Montezuma Slough where turbidity and prey densities can be higher at times (Sommer *et al.* 2015, their figure 4; Hammock *et al.* 2015, p. 320). SMSCG operation can also result in upstream movement of X2; however, the PA states that the projects will meet their D-1641 salinity requirements even if that requires additional Delta outflow to offset salinity changes at compliance points caused by SMSCG operation.

Reclamation and DWR have proposed to incorporate operations of the SMSCG for up to 60 additional days (may be non-consecutive) in Below Normal and Above Normal water year types. This action may also be implemented in Wet water year types if information suggests there are benefits of doing so. The purpose of the action is to direct more fresh water into the Suisun Marsh to create and maintain low salinity habitat there and in adjacent shoals in Grizzly Bay. The goals of the Summer-Fall Habitat Action relevant to critical habitat are to manage the overlap of low-salinity water with localized turbid areas and copepod production that may be less affected by the overbite clam (Hammock *et al*. 2017; Baumsteiger *et al*. 2017) and establish contiguous low-salinity habitat from the Cache Slough Complex to the Suisun Marsh (Moyle *et al*. 2010; 2016). Specific actions will be informed each year by the use of structured decision making to achieve habitat goals which will try to overlap low-salinity water (0 to 6 ppt at Belden's Landing from June to October), with turbid water (targeting at least 12 NTU) and highest available food supplies. The proposed management actions are described in Table 8-11.

The suite of management interventions in the Summer-Fall Habitat Action is intended to focus benefits into places like the Cache Slough Complex and Suisun Marsh where outcomes can be controlled and observed fairly carefully, and it will add actions to Below Normal water years, potentially increasing the frequency of years that the delta smelt population and critical habitat receives some helpful management intervention. The Service anticipates that the actions identified would continue to provide low-salinity habitat in Honker and Grizzly Bays and Suisun Marsh in Above Normal and Wet years and increase its frequency in Suisun Marsh in Below Normal years. Additionally, food subsidy actions, described at a stand-alone programmatic level, may provide better feeding conditions (increased prey density) for delta smelt in Suisun Marsh and the Cache Slough Complex. The structured decision-making process called for under this action will incorporate new results each year to help refine the potential benefits that may be realized.

Figure 8--26: Daily-averaged depth-average salinity in psu (practical salinity units) between Carquinez Strait and the western Delta for X2 located at 84. Source: Michael Mac Williams unpublished data.

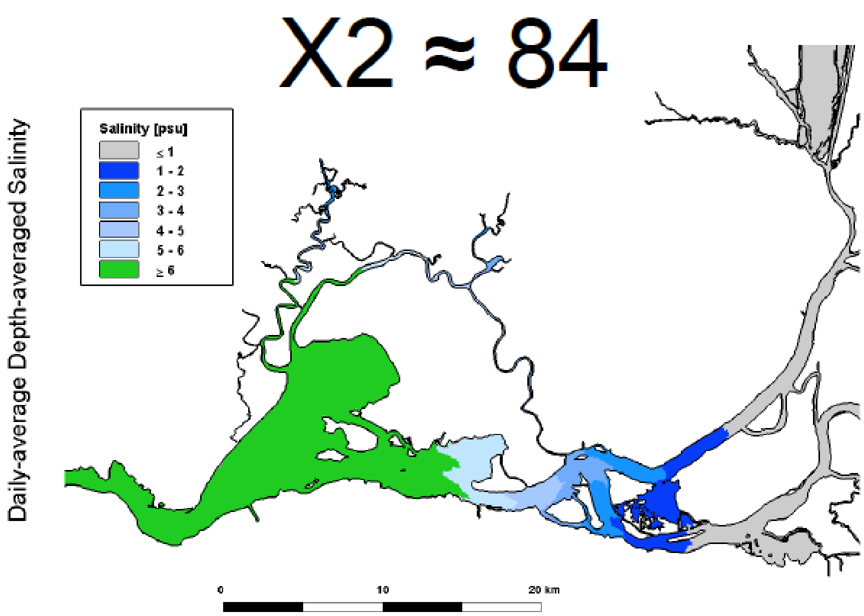


Figure 8--27: Daily-averaged depth-average salinity in psu (practical salinity units) between Carquinez Strait and the western

Delta for X2 located at 85

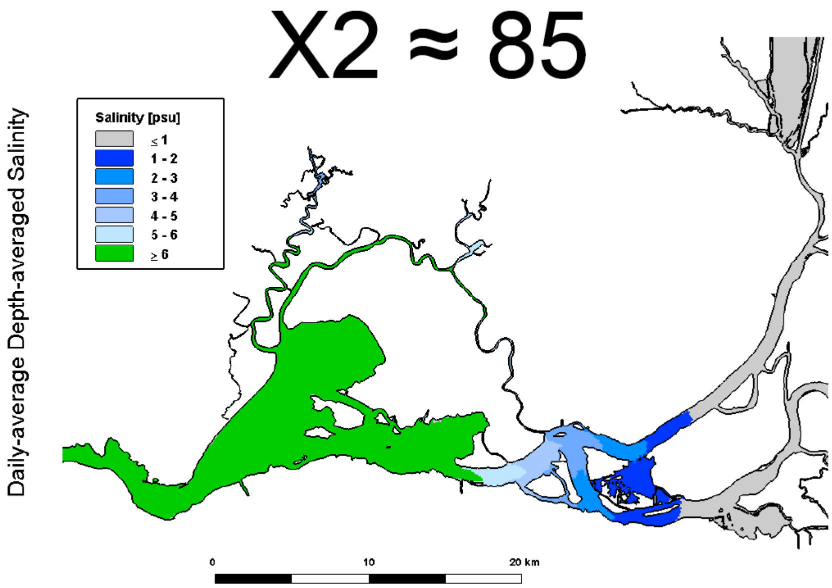
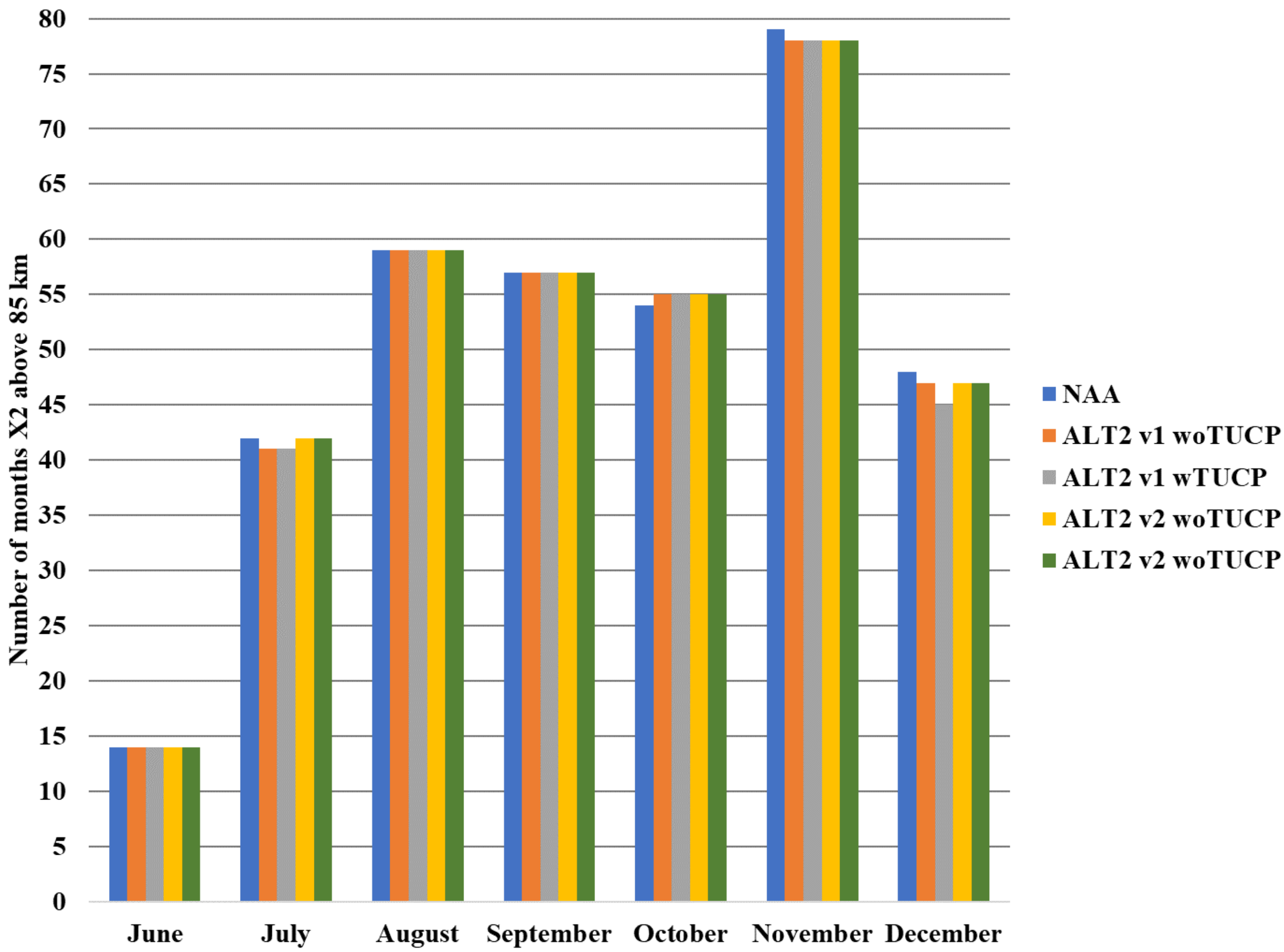


Figure 8--28: Comparison of the frequency of months (June-December) for the NAA and PA scenarios that CalSim 3 modeling (n=99 all months except September 98) indicates that X2 is at or above 85 km from the Golden Gate Bridge (no overlap of the low-salinity zone with Suisun Bay)



Habitat conditions supporting adult migration

PCE 3 – River Flow

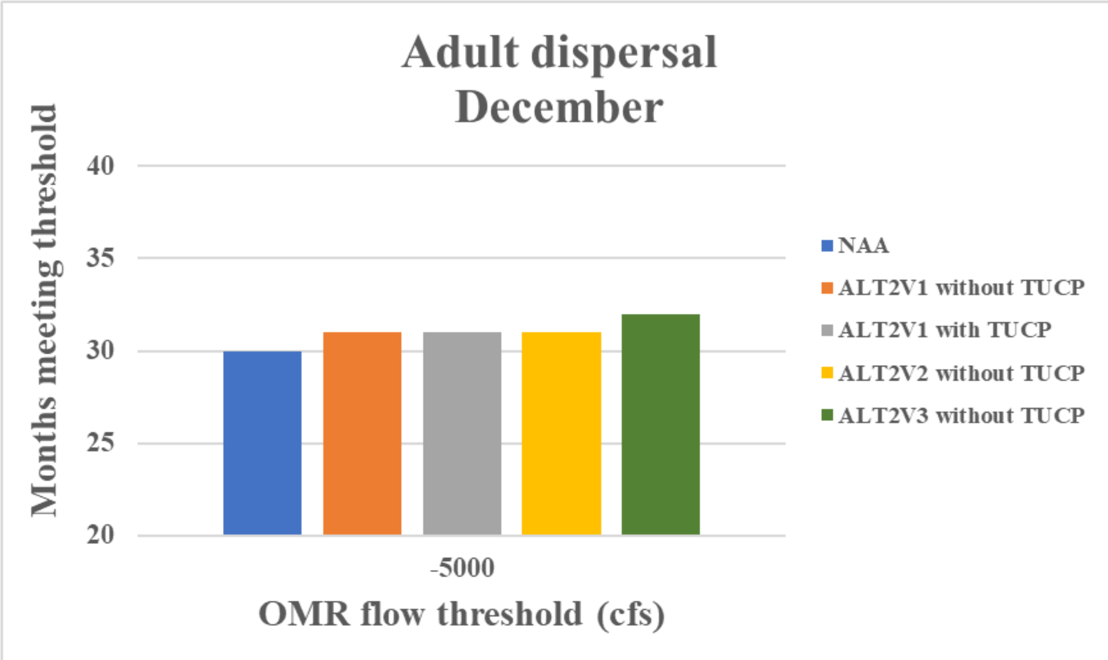
The adult migration period is defined in this BiOp as December to March to coincide with most historical salvage of adult fish (Grimaldo *et al*. 2009a). During this time, adult delta smelt need unrestricted access to suitable spawning habitat. These areas also should be protected from physical disturbance and flow disruption during adult migration. River flow includes inflow into the Delta and outflow from the Delta. Inflow, outflow, and OMR flow influence the vulnerability of delta smelt adults to entrainment at Banks and Jones

Pumping Plants. As discussed in the *Status of the Species and Critical Habitat* section, scientific understanding of factors affecting entrainment risk suggests that turbidity (a component of PCE 2), in addition to river flow, plays an important role in attracting migrating adults.

Freshwater flows in combination with increasing turbidity are cues for adult delta smelt to migrate to spawning habitat in December through March (Sommer *et al*. 2011). South Delta water exports could alter critical habitat by drawing turbid Sacramento River water into the central and south Delta, encouraging the migration of adult delta smelt further south and east, making them and their offspring vulnerable to entrainment. In all PA scenarios, OMR flows for all PA scenarios are proposed to be the same as the NAA in January through March, and slightly less negative than the NAA during December (Figure 8-29).

Additionally, the HRL proposes augmentation of outflow during March through May of 150-826 TAF of additional water, depending on water year type. This would improve flows in March for the adult migration period including reducing flows that would draw spawning adult delta smelt into the interior and South Delta where entrainment risk is high. OMR Management is proposed as a component of the PA and includes short-term periods during which, based on an assessment, OMR flow may be more negative than -5,000 cfs during Storm Flex actions but also includes a real-time decision process to limit the inflow of turbid water into the South Delta and pumping facilities during December through March. These actions include real-time adjustments to protect adult delta smelt. These management actions are expected to prevent turbid Sacramento River water from being drawn into the central and South Delta and will restrict net OMR flows to be -5,000 or more positive. If conditions are conducive for turbidity to be drawn into the South Delta, then OMR flows would not be more negative than -2,000 cfs. As stated above, this is expected to be protective of a high fraction of migrating adults. Predicted PA OMR conditions resulting from proposed water operations in combination with OMR management are expected to result in OMR flow conditions appropriate for migrating adults.

Figure 8--29: Comparison of X2 frequency of months that the five operations scenarios



<u>Recovery of Delta Smelt</u>

Recovery of listed species is one of the primary goals of the Act. The Act defines ‘‘conservation’’ to mean “to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary”. The regulations implementing section 7 of the Act include conservation and recovery considerations in the definitions. At the species level, to jeopardize the continued existence of a listed species means “to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species”. Destruction or adverse modification of designated critical habitat means “a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species”. In this section, we outline recovery needs of delta smelt and how the PA impacts recovery efforts.

The Service issued a *Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes* (Recovery Plan) in 1996 (Service 1996). The Service has used the most up-to-date, best available information to outline the recovery needs of delta smelt. Sources used to develop the needs include, but are not limited to:

- the March 5, 1993 delta smelt listing and critical habitat rule;
- the 1996 Recovery Plan;
- the 2008 Service BiOp (Service 2008);
- the September 17, 2023 5-year status review (Service 2023);
- the April 7, 2010 12- month finding (75 FR 17667; Service 2010b);
- the latest Candidate Notice of Review (Service 2023); and
- other resources available to the Service.

Based on available resources, the Service proposes that, in order to recover, delta smelt need a substantially more abundant population, efforts to supplement the number of individuals in the wild, an increase in the quantity and quality of habitat, and other needs as further outlined below:

Abundance - a substantially more abundant population, which is notably linked to the success of recruitment between life stages. Abundance is affected by entrainment, predation, feeding, competition, demographics, reproductive success, and fish condition and health.

Entrainment and Impingement Risk

- A reduction in entrainment and impingement of adult, juvenile, and larval individuals, and their food supply at CVP and SWP pumping facilities, over and above reductions achieved under ongoing real-time operations, to increase the abundance of the spawning adult population and the potential for recruitment of larvae and juveniles into the adult population. This can be done through OMR modified actions to increase protection among life stages.

- A reduction in entrainment and impingement from other water diversion-related structures within delta smelt critical habitat where delta smelt adults, larvae, or juveniles are known or are likely to be impinged or entrained to increase the adult population and the potential for recruitment of juveniles into the adult population.

- A reduction in entrained food supply within delta smelt critical habitat.

Predation

- Increased escape cover (*i.e.*, sufficient habitat to reduce/avoid predation from observed increases in water clarity).

- Reduction in predators in the Bay-Delta ecosystem to increase survival of adults, larvae, and juveniles from an overall increase in relative abundance of predator species system-wide.

Feeding

- Increased copepod production.

Competition

- Reduction in competition and food web alteration from non-native fish and invertebrates.

Demographic/Genetic

- Maintain or increase genetic diversity within the population and Allee effects (*e.g.*, reduced schooling ability, reduced ability to find mates).

Reproductive Success

- Restoration of migratory and spawning cues from reductions in the spawning season window and modification of natural flow regimes.

- Increase the condition of spawning individuals, such as fish size (*e.g.*, weight, length), fat storage, sufficient calorie intake, and lipid energy.

- Improve delta smelt vital rates, including higher growth rates and higher fecundity levels.

- Improve the sex ratio (males to females) with recognition that there is uncertainty associated with this need and therefore is identified as needing additional research and monitoring.

Fish Body Condition/Health

- Improve physical health through a reduction in contaminants exposure and other pollutants (*e.g.,* metals, pesticides, CEC's [endocrine disruptors], etc.) within its habitat to increase survival of adults, larvae, and juveniles.

Supplementation – The very low abundance of delta smelt has increased the urgency toward development of a program for supplementing the wild population of delta smelt (Lessard *et al*. 2018). This effort began as an experimental release study that has quickly over four years established a proof of concept. This study and others have paved the way to create a more permanent space in our recovery planning for release of cultured delta smelt into the wild for the primary purpose of supplementing the population. In order for a supplementation program to be fully successful, fish must be released into an environment that provides ample food, low levels of toxic compounds, and low entrainment losses. Other key aspects that influence the abundance and habitat are listed within this section in the pages above and below.

Habitat - an increase in the quality and quantity of suitable migratory, spawning, and rearing habitat. Improved habitat quality within the Bay-Delta should enhance delta smelt reproduction and allow for recruitment success necessary to the species to survive. Suitable habitat conditions require habitat diversity, water quality, and flow.

Habitat Diversity

- Increase habitat complexity (*e.g.*, reduction in dead end sloughs) and heterogeneity.

- Increase in the quality and quantity of suitable spawning habitat and substrate (*i.e.*, sandy beaches with sufficient water velocities, available for direct use) due to reductions in sandy beaches system-wide.

- Maintain or increase (*i.e.*, protect, restore, create, or enhance) suitable habitat within designated critical habitat (*i.e.*, with PCEs), further preventing reductions in habitat.

Water Quality

- Improve water quality – suitable water quality constituents within optimal range (*i.e.*, turbidity, dissolved oxygen levels, water temperature, pH, salinity).

Flow

- Improve flow conditions – suitable flow conditions (*i.e.*, velocity, timing, [delta] freshwater outflow, salinity, tidal energy, flow suitable for spawning migration, to trigger movement to spawning areas, and egg incubation)

- These can be achieved as a result of active or passive management of water and sediment processes in the San Francisco Bay-Delta ecosystem that mimics more natural (i.e., pre-water development) conditions.

Other needs – Other factors that affect delta smelt include climate change, aquatic invasive macrophytes, harmful cyanobacteria blooms (*Microcystis*), disease, and exposure to in-water work activities.

Climate Change

- Maintain and increase sufficient suitable habitat from threats of ecosystem changes (community and habitat shifts).

- Prevent reductions/shifts in suitable habitat due to sea-level rise and increased droughts and temperatures.

- Maximize delta smelt population resilience in the face of the potential adverse effects of ongoing climate change that are occurring in the Bay-Delta ecosystem.

Aquatic Invasive Macrophytes

- Reduce aquatic invasive macrophytes due to increased predator habitat from changes in water quality as a result of increased water clarity, residence times, and flow reductions.

Harmful Cyanobacteria Blooms (i.e., Microcystis)

- Reduce harmful cyanobacteria blooms from increased water residence time/flow reductions and increased anthropogenic nutrient inputs.

Disease

- Reduce disease to increase survival of adults, larvae, and juveniles.

Risk to Individuals from Exposure to In-water Work Activities (e.g., dredging riprapping, suction dredging, agricultural diversions)

- Reduce sources of harassment, harm, or mortality to delta smelt individuals, habitat loss, and effects to prey density (*i.e.*, modification of food supply).

Effects of the Proposed Action on Recovery

Reclamation and DWR are proposing measures to minimize the adverse effects of accumulating loss and degradation of habitat to promote the recovery of delta smelt. Habitat loss and degradation are contributing factors to the decline of delta smelt. The proposal to finish restoring intertidal and associated subtidal habitat in the Delta and Suisun Marsh, protecting and managing this habitat in perpetuity, and ensuring these restored sites are effectively functioning for the intended purpose is a reasonable means of minimizing the adverse effects of the loss of individuals, on the species as a whole, and may benefit the recovery of delta smelt. Tidal restoration projects in the estuary have generally created fish feeding benefits very quickly (Cohen and Bollens 2008; Howe and Simenstad 2011). Following Herbold *et al*. (2014), the restoration projects are sited and designed to locally increase food web production in locations where delta smelt should be able to access them. Reclamation and DWR commit to ensuring that monitoring, operation, maintenance, and permanent protection occur on these restored lands. An overall monitoring program developed to focus on the effectiveness of the restoration actions will inform future actions undertaken for the intended food web benefit of delta smelt. The Service is a member of the FAST, which assists DWR in designing the proposed restoration projects to increase food web production in appropriate locations to benefit delta smelt.

The proposed operation of the CVP and SWP is unlikely to increase delta smelt entrainment risk as compared to the current levels the species is experiencing. OMR Management measures in the PA are proposed to minimize the level of entrainment during the period when delta smelt may be migrating, spawning and when larvae and juveniles are subject to entrainment by restricting how negative OMR flows can be during these life stages. Food subsidy studies in the Adaptive Management Plan should be designed and located in areas where entrainment of those food subsidies is not expected to occur.

It is unknown if the Summer-Fall Habitat Action will contribute to recovery by improving habitat quality for delta smelt. Specific actions to be taken in applicable water years are to be determined by the Delta Coordination Group based on unique conditions for that year and results of previous implementation of SMSCG operations and adaptive management of food enhancement actions.

Reclamation and DWR propose to support development of the delta smelt Supplementation Program, including capturing existing genetic diversity, maximizing numbers of delta smelt produced in captivity under genetically sound management, and to begin supplementation of the wild population. The PA includes production of cultured delta smelt to levels sufficient to effectively supplement the wild population. However, the long-term objective of the Delta Smelt Supplementation Program would be to boost population abundance in the wild to a level that, minimally, supports annual return of wild-origin broodstock to self-sustaining levels. To assist getting there, by 2030, Reclamation proposes to construct a permanent facility to take over the role of supplementing the wild population, and will have the capacity to accommodate production of delta smelt needed to meet genetic and other hatchery considerations with a goal of increasing production to a number and the life stages necessary to effectively augment the population. This program will likely contribute to recovery by augmenting the population to the point that the wild population will be more resilient to threats, including effects associated with operations of the CVP and SWP.

As modeled, the PA is unlikely to increase the level of entrainment of adult and larval delta smelt relative to the NAA and negative effect of entrainment will be minimized by real-time measures that are part of the PA to protect delta smelt. Additionally, supplementation is expected to improve abundance and distribution to help bolster the wild population and make it more resilient. It is unknown what effect to recovery some components of the PA will have, such as implementation of the Summer-Fall Habitat Action. Habitat restoration efforts are and will contribute to the delta smelt food web, which contributes to the recovery need of increased abundance by improving food availability for delta smelt in areas where delta smelt should be able to access it. The adaptive management proposal to study and ensure effectiveness of these sites should further ensure this beneficial effect to the species. Therefore, overall the PA is not likely to preclude, and some actions may contribute to, recovery of the delta smelt.

e. Cumulative Effects

Cumulative effects include the effects of future State, tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this BiOp. Future Federal actions that are unrelated to the proposed project are not considered in this section; they require separate consultation pursuant to section 7 of the Act.

Major human interactions and uses of the landscape within the Action Area include agricultural practices, recreational uses, urbanization, transportation, transcontinental shipping, and industrial uses. All of these major land uses contribute to greenhouse gas emissions.

Agriculture

Farming occurs throughout the Delta and its watershed, including on lands adjacent to many waterways used by delta smelt. Levees are reinforced with continual vegetation removal and over time, riprapping has accumulated as a commonly deployed method to stabilize the levees and protect the land behind the levees for agricultural purposes. Agricultural practices introduce nitrogen, phosphorous and other nutrients into the watershed, which then flow into receiving waters, adding to other inputs such as wastewater treatment (Lehman *et al.* 2013); however, urban wastewater treatment provides the bulk of ammonium loading (Jassby 2008). Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect delta smelt reproductive success and survival rates (Dubrovsky *et al.*1998; Kuivila *et al.* 2004; Scholz *et al.* 2012). Discharges occurring outside the Action Area that flow into the Action Area also contribute to contaminant exposure.

Water diversions for irrigated agriculture, municipal and industrial use, and managed wetlands are found throughout the Action Area, and many of them remain unscreened. Depending on the size, location, and season of operation, these unscreened diversions have the potential to entrain many life stages of aquatic species, including delta smelt (Nobriga *et al*. 2004). Most diversions of any substantial size and cost along the Sacramento River have been screened, and in the Delta, newer municipal water diversions and are routinely screened per existing BiOps. Private irrigation diversions in the Delta and Suisun Marsh are mostly unscreened, but the total amount of water diverted onto Delta farms and waterfowl clubs has remained stable for decades (Culberson *et al.* 2008) so the cumulative impact should remain similar to baseline.

Urbanization and Industry

Increases in urbanization and housing development can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, and electricity, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions will not require consultation regarding delta smelt.

Adverse effects on delta smelt and its critical habitat may result from urbanization-induced point and non-point source chemical contaminant discharges within the Action Area. These contaminants include, but are not limited to, ammonia, numerous pesticides and herbicides, pharmaceuticals and their degredates, personal care products, vehicle and roadway-derived copper, and oil and gasoline product discharges. Oil and gasoline product discharges may be introduced into Delta waterways from shipping and boating activities and from urban activities and runoff. Implicated as potential stressors to delta smelt, these contaminants may adversely affect delta smelt reproductive success, survival rates, and food supply.

Other future, non-Federal actions within the Action Area that are likely to occur and may adversely affect delta smelt and their critical habitat include: the dumping of domestic and industrial garbage that decreases water quality; oil and gas development and production that may affect aquatic habitat and may introduce pollutants into the water; and State or local levee maintenance that may also destroy or adversely affect habitat and interfere with natural, long-term habitat-maintaining processes.

Greenhouse Gas Emissions

The world's climate is warming (IPCC 2001; 2007a, b, c; 2014) due in large part to emissions of carbon dioxide and other greenhouse gases (GHGs) in the atmosphere as a result of human activities, particularly the use of fossil fuels (IPCC 2007b; Solomon *et al.* 2009). Scientists use a variety of climate models, which include consideration of natural processes and variability, as well as scenarios incorporating current and potential future GHG emissions to predict how the climate will change and what the consequences will be for global weather patterns, ocean current systems, the global hydrologic cycle (including polar ice), and aquatic and terrestrial ecosystems (e.g., Meehl *et al.* 2007; Ganguly *et al.* 2009; Thompson *et al*. 2021). Global climate models have been downscaled so they can be applied to particular locations, for instance, to the western U.S. (Dettinger *et al*. 2015) and the Central Valley (Dettinger 2005; Dettinger *et al*. 2016). All combinations of climate models and emissions scenarios yield very similar projections for the Bay-Delta region, consistently predicting increases in sea level and air temperature, with higher uncertainty in predictions of average precipitation. *However, t*here is also increasing scientific recognition that weather in California will become more variable and include a higher frequency of drought conditions (Swain *et al*. 2018).

Climate change is already affecting delta smelt mainly via warming water and high drought frequency over the past 25 years (Halverson et al. 2022, entire; Mahardja et al. 2021, entire). Ongoing climate change can be expected to worsen conservation challenges for delta smelt through multiple mechanisms (Brown *et al*. 2016b). Higher salinity stemming from sea level rise will affect distribution and habitat conditions (Feyrer *et al*. 2011). Higher temperature will exacerbate already substantial summer bioenergetic stress (Smith and Nobriga 2023) and will continue to incentivize the reproduction and population expansions of warmer water tolerant predators and competitors (e.g., Conrad *et al*. 2016; Mahardja *et al*. 2016; Huntsman *et al*. 2021). Rapidly warming springtime temperatures (Bashevkin *et al*. 2022) will change the timing of reproduction and may constrict the length of the reproductive season (Brown et al. 2016b). This coupled with limited growth due to energetic stress may greatly limit per capita reproductive output because individual egg supply is associated with adult fish length (Lindberg et al. 2013, their Fig. 2; Damon et al. 2016, their Fig. 4). Recent drought cycles have taxed California's water system and resulted in overall environmental conditions in the estuary that do not support completion of the delta smelt's life cycle (Bosworth *et al*. 2024).

Changes in the timing and duration of important life stage events and developmental processes, as described above, could have direct, physiological impacts on delta smelt or could alter phenological synchrony with suitable habitat availability (Huntsman *et al.* 2024, p. 16) and interacting species (e.g., Merz et al. 2016, entire). For example, a constricted juvenile maturation period could lead to reduced growth, condition, and consequently fecundity (Brown *et al.* 2016b). The seasonal timing of prey availability could also change in response to directional change in climatic conditions. Delta smelt rely on zooplankton prey that have experienced changes in species composition and reductions in biomass (Winder and Jassby 2011, their Tables 1-2 and Figures 5-7) along with significant shifts in the timing of peak productivity (Merz *et al.* 2016, their Table 2). Merz *et al.* (2016, pp. 1532 and 1534) suggested that shifts in the peak production of some zooplankton taxa since the mid-1980s could have contributed to reduced food availability for delta smelt. Although these shifts did not coincide with a directional change in temperature or other climatic conditions (Merz *et al.* 2016, their Table 2), changes in temperature have been shown to contribute to changes in zooplankton phenology (e.g., Winder *et al.* 2009) and potential mismatches with critical life stages of their fish predators (e.g., Chevillot *et al.* 2017).

Delta smelt critical habitat and population dynamics are also anticipated to be impacted by hydrologic responses to climate change, including seasonal inflow patterns and sea level rise. The timing and source of high unimpaired runoff into the estuary is changing from spring snowmelt-dominated to a hydrograph dominated by winter rains (Knowles *et al.* 2018, p. 7641), which will result in higher peak flows and greater risk of flooding earlier in the water year but drier springs (Dettinger *et al.* 2016, p. 12 and their Figure 5). In contrast, reduced inflows during the dry season (late spring through fall, increasingly, May-December; Figure 8-4), in combination with sea level rise, will increase saltwater intrusion into the estuary when juvenile delta smelt are rearing in the low-salinity zone. Depending on the level of sea level rise, X2 could increase by greater than 1-3 km by 2050 (Service 2022, based on MacWilliams and Gross 2010). As a result, the low-salinity zone will be shifted inland with increased frequency, forcing delta smelt to try to rear east of Chipps Island where foraging habitat conditions are of low quality for months (Smith and Nobriga 2023). Although delta smelt have been shown to acclimate to high salinities in a laboratory setting we explained above why laboratory results are frequently not transferable to delta smelt in the wild (see section *z. Laboratory studies*). Therefore, greater salinity intrusion is expected to further reduce habitat availability by limiting the ability for rearing delta smelt to shift their distribution seaward into areas that have historically had cooler water temperatures. Proximity to tidal wetlands was hypothesized as important for providing food subsidies to delta smelt (Sommer and Mejia 2013, p. 18) and later shown to increase the foraging success of juvenile and adult delta smelt by 1.4 times (Hammock *et al.* 2019a, p. 863); however, temperatures above 23-24° C are likely to limit growth regardless of how much food is available (Smith and Nobriga 2023, their Fig. 2c). Further, sea level rise has the potential to lead to the conversion of freshwater and brackish high marsh habitat to low marsh habitat by 2100 or sooner (Service 2022); but marshes in the Delta may be able to keep pace for 50 years or more.

Summary of the Cumulative Effects to Delta Smelt

The anticipated cumulative effects to delta smelt within the Action Area include additional urban and commercial development in the Bay-Delta watershed, and the increased stormwater runoff, road building, and changes to contaminant loading that accompany these land use changes. There may be small reductions in regional agriculture and in-Delta irrigation diversions due to the development of the 8,396.3 acres of habitat restoration and other habitat restoration initiatives like EcoRestore. The Service is not aware of any information that can be used to quantitatively predict what the cumulative effect of such changes would be. Qualitatively, habitat restoration and less irrigation water demand in the Delta have the potential to offset increased contaminant burdens associated with projected human population growth and urban/commercial land conversion. The amount of anticipated change to the regional climate expected in the near term is lower than it is for the latter half of the century. Therefore, it is less certain that any measurable change from current conditions will occur in the next approximately 10 years than by the latter half of the century. For the time being, water temperatures are stressful to delta smelt, but not of themselves lethal in most of the upper estuary (Komoroske *et al.* 2015).

Summary of the Cumulative Effects to Critical Habitat

Among the cumulative effects discussed in *Cumulative Effects* section, urbanization and climate change are most likely to affect critical habitat. PCE 2 (Water Quality) impairment is likely to continue or increase due to ongoing inputs of irrigation drain water, increased stormwater runoff and the pesticides associated with these inputs. Water temperatures, influenced by warming air temperatures from climate change, are expected to rise. Delta smelt is currently at the southern limit of the inland distribution of the family Osmeridae along the Pacific coast of North America and is living in an environment that is energetically stressful. Thus, any increase in summer water temperatures associated with climate change may present a significant conservation challenge. PCE 3 (River flow) reductions, and the associated PCE 4 (Salinity) intrusion will increase as human population growth places additional demands on water resources and less fresh water will be available to maintain the low-salinity zone at a suitable location particularly for juvenile rearing habitat. Herren and Kawasaki (2001) documented over 2,500 water diversions in the Delta and Suisun Marsh, of which very few are screened. Unscreened diversions represent a risk of entrainment to delta smelt and reducing habitat suitability for all life stages especially larvae and juveniles when river flow is directed over levees onto fields or managed wetlands (Culberson *et al.* 2004). Of the 414 water diversions in Suisun Marsh approximately 98% were unscreened including DWR's Morrow Island Distribution Center. Climate change will also alter the timing and form of precipitation (rain or snow) in the watershed depending on latitude. Sea level rise could accelerate quickly depending on what happens in remote locations; if so, it will likely influence saltwater intrusion into the Bay-Delta. Elevated salinity could push X2 farther up the estuary with mean values increasing by about 7 km by 2100 (Brown *et al.* 2016b). The status of critical habitat (PCEs 2, 3 and 4) will likely be degraded by each of these cumulative effects in the near term.

f. Summary of Aggregated Effects

Effects of the Aggregate Status of the Species/Environmental Baseline, and Proposed Action for Delta Smelt

The purpose of the aggregate analysis is to evaluate the combined status and baseline of the species, the effects of the PA and the cumulative effects of non-Federal activities to determine their combined effects to the species. Reclamation has committed to implementing certain programmatic actions that will be subject to future consultation, so those effects have been analyzed at a general level since specific details about those activities have not yet been developed, and the analyses of those actions at this stage are focused on the proposed frameworks for the future consultations. Subsequent consultation on those activities will include analyses of effects at a more specific level and will address incidental take of listed species if it is reasonably certain to occur.

As discussed in the *Environmental Baseline* section of this BiOp, the Environmental Baseline does not include the effects of the action under review in the consultation. We have largely incorporated by reference the Environmental Baseline from the BA, although we do discuss the condition of the food web in the estuary and the long-term accumulation of change in delta smelt's critical habitat. The *Environmental Baseline* section describes factors that have led to the current condition of the delta smelt, including past operations of the CVP and

SWP, habitat restoration, and other effects on species from Federal, State, and private actions.

Summary of the Status of the Species and Critical Habitat

The Action Area for this consultation encompasses the entire range of delta smelt including all of the designated critical habitat for this species, so for the purposes of this consultation, status of the species range-wide and in the Action Area, as well as status of critical habitat, are combined. As discussed in the 2019 biological opinion on the long-term operations of the CVP and SWP, the range-wide status of the delta smelt has been declining since the early 2000s (Service 2019). At that time, delta smelt had become almost undetectable in some surveys since 2012 (Moyle *et al*. 2016). The population was thought to be so small that stochastic factors, such as a multi-year drought, the loss of key spawning or rearing sites, or an increase in local abundance of competitors or predators could cause extinction in the wild in the near future (Moyle *et al*. 2016). For an annual species, factors affecting habitat conditions throughout its short life span are important to its success or failure. It is clear from published research that the delta smelt population declined for multiple reasons including degradation of physical and biological aspects of its habitat and in association with increasing abundance of some non-native species (Mac Nally *et al.* 2010; Thomson *et al*. 2010Mahardja *et al*. 2017).

The anticipated effects of climate change on the Bay-Delta and its watershed such as warmer water temperatures, greater salinity intrusion, lower snowpack contribution to spring outflow, and the potential for frequent extreme drought, indicate challenges to delta smelt survival that are already concerning will further intensify.

The status of delta smelt in the Action Area has changed notably since 2019 as it is now a conservation-reliant species with most individuals completing a large majority of their life cycle in captivity at the FCCL (Lindberg *et al.* 2013, entire). Because the delta smelt was nearly extirpated when experimental releases of captive-bred fish began in December 2021, it is unlikely that individuals without any FCCL ancestry still exist. Thus, the delta smelt now exists only as an integrated hatchery-wild population. Under current conditions, the delta smelt would be quickly extirpated (likely within at most, a few years) if the annual re-introductions of these 'experimental release' fish were discontinued.

The primary purpose of designated critical habitat is to provide the key components of delta smelt habitat that support successful completion of the life cycle, including spawning, larval and juvenile transport, rearing, and adult migration back to spawning sites. Delta smelt are endemic to the Bay-Delta and the vast majority of wild-born individuals only live one year. Thus, regardless of annual hydrology, the Bay-Delta estuary must provide suitable habitat all year, every year; however, it no longer does.

A NAA scenario has been incorporated into our effects analysis to aid in identifying aggregate effects (including identifying future effects of the PA components that have not changed from current operations, as well as identifying effects of the components of the PA). The NAA essentially represents current operations of the CVP and SWP. Where adverse effects of the PA are expected to increase relative to current operations, those increases and to which life stages they occur, have been explained in our effects analysis. Where beneficial effects of the PA may or are likely to occur, those have also been explained. Where it is currently unknown what effects will occur because of a lack of specific information about how the action will be implemented, those have also been noted. There have also been numerous other consultations and projects that have affected delta smelt in addition to past consultations on operations of the CVP and SWP.

Therefore, the summaries of aggregate effects to the delta smelt and its critical habitat described below for use in considering whether or not the PA is likely to jeopardize delta smelt or destroy or adversely modify critical habitat (pursuant to the Analytical Framework for the Jeopardy Determination and Analytical Framework for the Adverse Modification Determination) reflect our consideration of the effects of the PA in light of all of the factors leading to the current condition of the species and critical habitat, including the effects of past and current operations of the CVP and SWP, the recent experimental release of cultured delta smelt to the wild, and cumulative effects.

<u>Summary of the Effects of the PA on the Reproduction, Numbers, and Distribution of Delta Smelt</u>

As noted in the *Effects of the Action* section above, in recent years the status of the species has changed greatly to a conservation-reliant circumstance, and there have been substantial scientific contributions to population dynamics that help inform development of the PA and substantiate predicted effects. Both of these greatly improve our ability to evaluate effects in aggregate and to parse apart some mechanisms that stem from freshwater flow variation. Further, hydrologic modeling involves considerable parsing of how different opportunities and constraints on operations (climate, end users, environmental regulations) interact to affect the estuary's flow regime, which allows for more insight into baseline effects stemming from cumulative system change over the past 170 years and their separation from effects resulting from the water operations and other actions described in the PA.

<u>Reproduction</u>

Operations of the CVP and SWP as described in the PA will have impacts to delta smelt reproduction. Favorable conditions in the winter and spring months are critical to successful adult delta smelt dispersal and spawning. Proposed OMR management measures are designed to provide adult protections to minimize entrainment and are expected to provide conditions similar to the NAA. Implementation of these measures will help ensure that delta smelt recruitment is less impacted by entrainment losses.

It is unknown whether the captive-bred fish that now dominate the adult spawning stock behave the same way that the historical population did. The 'natural' mortality rates of the released fish, due to sources other than entrainment and sampling are notably higher than had been estimated for the historical wild population using LCME (Service unpublished data). Additional sources of mortality that released fish experience, but wild delta smelt do not, include transport from the hatchery, release of naive fish into habitats with predators, and the environmental conditions into which fish are released. If natural mortality increases, more fish die before having the opportunity to be entrained, resulting in a smaller fraction entrained. As such, entrainment of subadult and adult delta smelt may have a fractionally smaller population effect than it did on the historical wild population from 2009 through 2021; however, the population growth rate of delta smelt even with experimental release remains negative as it has for most of the 21st century.

The increasing production of delta smelt at FCCL, experimental release that has already occurred, and near-term population supplementation will help conserve diversity and may increase resilience by augmenting the reproduction of delta smelt in the wild. Putative offspring of experimentally released fish have been captured in fish monitoring and at the salvage facilities and provides evidence that experimentally released fish are successfully reproducing in the wild. Greater numbers of successfully reproducing delta smelt will bolster the resilience of the population in poor recruitment years and allow the population to withstand conditions such as drought. Eventually, production and supplementation will be substantially increased as proposed, providing additional demographic benefits to delta smelt.

Numbers

By operating the existing CVP and SWP export facilities, there is ongoing potential risk to delta smelt individuals (especially larvae, juveniles, and adults) from entrainment or impingement and increased predation rates. The proposed OMR management strategy generally conforms to current best available information by combining limits on how negative net OMR flow can be with turbidity triggers. These proposed operations will not eliminate larval, juvenile and adult delta smelt entrainment, but they should help to keep it at levels similar to what has occurred since 2009 when OMR management first came into full effect. Proportional entrainment of the sub-adult and adult point estimates range from monthly losses of about 9 to 16 percent of the population.

Since the onset of OMR management in 2009, Smith et al. (2021, their Fig. 2) estimate that proportional entrainment of post-larval delta smelt has tended to stay under about 10 percent of the population. The point estimates for post-larvae range from losses across April through May of about 8 to 10 percent of the population.

Reclamation proposes to implement a suite of protective OMR management actions that we anticipate will maintain conditions that are similarly protective for adult delta smelt as those that have been in place since 2009. The intent of actions slated from December through June will be to minimize the effect of entrainment to adult delta smelt dispersing into the South Delta, which will minimize the number of entrained individuals and their progeny that are subjected to entrainment, poor habitat conditions and predation. The best available modeling information we have suggests there is no discernable quantitative effect of the PA on predictions of delta smelt population growth rate relative to the NAA; however, the population growth rate of delta smelt even with experimental release remains negative as it has for most of the 21st century. In addition, the spring Delta outflow proposed in the HRL may have incremental beneficial effects on delta smelt, predominantly by lowering entrainment, as compared to the NAA.

The LCME results indicate that greater numbers of successfully reproducing delta smelt will bolster the resilience of the population in poor recruitment years and allow the population to withstand poor conditions such as drought. Production and supplementation will increase substantially in the coming years through Reclamation’s commitment to support the supplementation program, which will serve to further minimize the population-level effects of operations of the CVP and SWP. Supplementation of the delta smelt population in the winter will help rebuild the wild stock, working in concert with comprehensive OMR management throughout the winter and spring to lessen the risk of entraining too many fish.

The spatial extent of suitable rearing habitat for delta smelt will be influenced by how the Summer-Fall Habitat Action is implemented. The PA has no summer outflow ‘action’ explicitly intended to help with delta smelt conservation, but Reclamation and DWR elevate

Delta outflow during July through October to create a 'hydraulic salinity barrier' that serves to maintain salinity standards mandated by the SWRCB and maintain the quality of exported water (Reis et al. 2019, p. 8). Adaptive experimentation could be helpful to determine if measurable benefits could be achieved by shifting some flow augmentation to summer months. From the CalSim 3 modeling, predicted changes in Delta outflow did not translate into discernable differences in life cycle model predictions of delta smelt population growth rate. So absent supplementation, the population would be expected to decline and quickly be extirpated. The proposed Fall X2 action could have effects on small numbers of delta smelt and the effects could have positive or negative consequences, but with the current available information, is not anticipated to have observable effects. Adaptive experimentation of flows in the fall and summer is proposed in the AMP to help elucidate timing and amounts of flow necessary to have observable effects.

If the contemporary integrated delta smelt population distributes in salinity space similarly to the historical wild population, then operation of the SMSCG during June through August may result in improved habitat conditions for up to about 10 percent of the juvenile delta smelt population due to the SMSCG action. By fall, we expect the upper bound to rise to about 20 percent of the population. It is likely that some delta smelt would be entrained into the Suisun Marsh as the gates are operated, but the number is unquantifiable.

Distribution

The PA is not expected to change the spatial distribution of the delta smelt relative to the NAA except when HRL outflow augmentations are occurring. Reclamation and DWR have proposed to manage OMR starting in December or January and through spawning (ends ~ April) and larval rearing (ends ~ June) to minimize any reduction in habitat that might result from periods of higher exports during these seasons. Larvae that hatch in these areas rely on net downstream transport flows in the spring to avoid eventual entrainment or predation within the large SAV beds in the channels and flooded islands of the South Delta. Thus, OMR management is anticipated to help minimize the loss of the larval and juvenile life stage to levels similar to the NAA.

Other factors that may affect delta smelt distribution include the operation of the agricultural barriers and the DCC. Adult fish may come into contact with these structures as they are moving upstream, but this possibility is low given that the agricultural barriers are put into place relatively late (April) when most adult delta smelt have already spawned and died. Larval distributions will be affected much more by OMR and turbidity than the operation of the temporary barriers. Based on historical distribution, it is unlikely that this will affect a large number of individuals that were not already entrained into Old and Middle rivers. Individuals encountering the agricultural barriers may be precluded from moving within the channel and made more vulnerable to predators hovering around the barriers and gates, but these fish were already assumed to be entrained or lost to predators in our effects analysis. It is unknown what (if any) effects the DCC or SMSCG operations have on dispersing adults.

Similar effects could occur through operation of barriers under drought conditions. The hydrologic modeling done to support the PA included the agricultural barriers and the DCC but did not include the proposed drought barriers. Therefore, operations with drought barriers in place will undergo subsequent analysis and consultation to determine the extent of their effects to hydrodynamics. The effects to distribution of delta smelt with drought barriers in place is unknown at this time.

The implementation of the PA will likely result in similar delta smelt distribution in the low-salinity zone as compared to the NAA. The HRL flows in some springs may influence larval distribution. Adaptive experimentation of summer and fall flows may result in shifts in juvenile distribution depending on how those experiments are designed and implemented, but since the purpose will be to achieve observable benefits to delta smelt survival, these studies should result in similar or possibly improved distribution of rearing habitat for delta smelt.

As proposed by Reclamation and DWR, the remainder of the 8,396.3 acres of restored habitat will be constructed, protected and managed by 2026. It is anticipated that this habitat will function as originally outlined in the 2008 BiOp and reiterated in the 2019

BiOp including food web benefits. These restoration projects are sited in areas designed to maximize food production and distribution to areas where delta smelt would benefit from access to it. In addition, tidal habitat effectiveness monitoring is now proposed as an adaptive management action to further ensure these projects function into the future and take actions to improve their functionality if necessary.

Overall, while the PA will result in certain negative effects to the reproduction, numbers and distribution of delta smelt, it will also result in beneficial effects through protective real-time operations actions, habitat restoration, and continued support of a Delta Smelt Supplementation Program. Near-term population supplementation will offset the negative effects of operations of the CVP and SWP. Augmentation of delta smelt in the wild will enhance the resiliency of the delta smelt population and may make them less vulnerable to stochastic events.

g. Conclusion

Delta Smelt and Delta Smelt Critical Habitat

After reviewing the current status of the delta smelt and its critical habitat, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of delta smelt. Additionally, it is the Service's biological opinion that the PA is not likely to destroy or adversely modify delta smelt critical habitat. We have reached these conclusions because:

- Implementation of the OMR management actions in the PA are designed to minimize impacts to delta smelt and its critical habitat, primarily through minimization of entrainment of migrating adult delta smelt and their progeny. This will also minimize the number of delta smelt subject to poor habitat conditions and predation. These protective actions are designed to prevent conditions which are conducive to entrainment, such as formation of turbidity bridges, and maintain the intended conservation value of critical habitat.

- The PA includes actions that maintain and in some cases improve habitat quality and extent, such as completing the tidal habitat restoration and the Summer-Fall Habitat Action, which is proposed to create fresher conditions in the marsh and will provide suitable rearing habitat for juvenile delta smelt in Honker and Grizzly bays, Suisun Marsh and Cache Slough.

- As described in the *Status of the Species and Critical Habitat* section of this BiOp, the delta smelt now exists only as an integrated hatchery-wild population and would be quickly extirpated (likely within at most, a few years) if the annual re-introductions of these 'experimental release' fish were discontinued. Reclamation's continued support of a Delta Smelt Supplementation Program will offset the negative effects of operations of the CVP and SWP. Augmentation of delta smelt in the wild will enhance the resiliency of the delta smelt population by replacing individuals subject to entrainment and other effects of operations and bolstering the estimated abundance of the population.

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9. Giant Garter Snake

a. Status of the Species

The Service listed the giant garter snake as a threatened species on October 20, 1993 (Service 1993). In 2017, the Service issued the final *Recovery Plan for the Giant Garter Snake* (Thamnophis gigas) (Service 2017, https://ecos.fws.gov/docs/recovery_plan/20170928_Signed%20Final_GGS_Recovery_Plan.pdf.) Threats evaluated during the drafting of the recovery plan and discussed in the final document have continued to act on the species since its publication, with loss of habitat being the most significant effect. The most recent 5-year review was completed in June 2020 where no change in status was recommended (Service 2020, https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2976.pdf). Please refer to the 2017 Recovery Plan for the species' general description and the 2020 5-year review for the recent comprehensive assessment of the species' range-wide status and updated life history and habitat preferences.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

c. Environmental Baseline

Six populations described in the Recovery Plan occur in the Action Area:

Yolo Bypass Population

The Yolo Bypass is a leveed, 59,300-acre floodplain located about 5 miles west of Sacramento. It is California's largest contiguous floodplain and provides valuable habitat for a wide variety of aquatic and terrestrial species (Sommer *et al.* 2001). When flooded, the Yolo Bypass provides up to about 59,300 acres of shallow floodplain habitat, with a typical mean depth of 6.5 feet or less. Depending on the amount of flow, the size of the flooded area of the Yolo Bypass can range from 1.2 to 6 miles wide over its 41-mile length

(Sommer *et al.* 2008). The 16,770-acre Yolo Bypass Wildlife Area (YBWA) is located in the Yolo Bypass from the railroad crossing just north of the I-80 causeway between West Sacramento and the City of Davis, California. The YBWA is managed by CDFW for recreation, hunting and environmental education. The YBWA is bounded to the west and east by the bypass levees with a small portion lying outside the western levee. Elevations vary with some areas remaining dry during all but the highest Yolo Bypass flood levels. The eastern bypass levee separates the Yolo Bypass from the Sacramento River Deep Water Ship Canal.

Portions of the YBWA are managed as prime farmland to grow crops that provide valuable habitat for a diversity of wildlife species. Rice crops provide habitat for a variety of waterfowl and giant garter snakes. The YBWA includes a variety of created and natural wetlands. Some of these wetlands are permanently flooded with islands and shallow underwater shelves while others are managed as seasonal wetlands that are flooded up during the waterfowl over-wintering and migration seasons and drained from April through August. These wetland systems are connected with agricultural fields through a variety of drainage facilities including pumps, delivery ditches, water control structures, and drainage systems.

There are 47 records in the California Natural Diversity Database (CNDDB) (CDFW 2024) of giant garter snakes in the Yolo Bypass with the majority of sightings located at the upper portion of the Yolo Bypass between Interstate 5 and Interstate 80 in a location known as Conaway Ranch. There are 8 recent sightings reported into CNDDB from 2018 to 2022 in the Southern portion of the Bypass of the Cache Slough complex along Lookout Slough and Shag Slough near Liberty Island. Field research conducted by Brian Halstead of U.S. Geological Survey (USGS) - Western Ecological Research Center captured several giant garter snakes in the southern portion of the Bypass in Lookout Slough (B. Halstead pers. comm. 2019).

Delta Basin Population

The Action Area includes the sub-population in the Delta Basin Population and Recovery Unit as defined in the *Recovery Plan for Giant Garter Snake* (Service 2017). The Delta Basin includes portions of Sacramento, Yolo, Solano, Contra Costa, and San Joaquin counties. A large portion of the Sacramento-San Joaquin Delta area has not been comprehensively surveyed for the giant garter snake, primarily because the majority of land is privately owned. The population status of giant garter snakes in the Delta is relatively undetermined and likely underestimated because sightings are sporadic in time and distance. As an example, an individual giant garter snake was sighted on Sherman Island near the Antioch Bridge in 1987 with a single reoccurring sighting in 2012 (CDFW 2024), a newer sighting in April of 2016 (Service 2019) and a most recent sighting across the San Joaquin River from Sherman Island at Antioch Point in 2022 (CDFW 2024). A documented sighting of a dead individual was recorded in 2010 around Empire Cut in the South Delta, a live individual was found at Webb Tract in the central Delta in 2014 (CDFW 2024), and the most recent occurrences of several live and one dead individual were found in the riprap shoreline on Jersey Island with another possible individual sighted across the waterway by the landowner on Bradford Island during the installation of the 2015 rock drought barrier on False River (DWR 2015). Up to six confirmed sightings of individuals on Sherman Island, Twitchell Island, and Bradford Island have been documented since March of 2016 (Service 2019). Most recently, seven giant garter snakes were observed basking in the riprap shoreline of Jersey Island during a pre-construction survey on May 31, 2017. Seven giant garter snakes were again documented the following day on June 1, 2017. Ten snake skin sheds, presumed to be giant garter snakes from the visible faint stripe patterning, were also documented in the same vicinity (Stillwater Sciences 2017).

The recent sightings within the last several years were mostly by chance and not part of focused surveys which in contrast have had difficulty detecting giant garter snakes in the Delta. Swaim Biological Consulting conducted a series of surveys for giant garter snakes from 2004 to 2005 near the City of Oakley in Contra Costa County, which comprises a large portion of the Hotchkiss Tract immediately south of Bethel Island. No giant garter snakes were found although the trapping effort included both aquatic and terrestrial trap-lines, and was conducted during the active season for the snake (Swaim 2004, 2005a, 2005b, 2005c, 2005d, 2006). DWR also conducted a trapping survey of various sites within the Delta including Sherman Island and Holland Tract that met habitat assessment criteria for giant garter snakes during the summer of 2009 (DWR 2010). No giant garter snakes were trapped or observed during those surveys either. Currently, the only known source population for giant garter snakes in the Delta region is located in the Eastern Delta at Caldoni Marsh near the City of Stockton. However, it is unlikely that the recent occurrences of giant garter snakes found in the Central and Western Delta originated from Caldoni Marsh considering the distances of those occurrences from Caldoni Marsh, the distances between occurrences, and the estimated dispersal range from telemetry studies. The recent number of documented occurrences within close proximity of each other in the western portion of the Delta suggests there is likely a reproducing population of giant garter snakes in this region. It should also be noted that giant garter snakes in this area are evidently using a habitat feature such as riprap along the edge of a large body of moving water like the San Joaquin River that other giant garter snakes have not been observed using with any frequency elsewhere. Large (400 - 700 acres) non-tidal wetland restoration efforts were conducted both on Sherman Island through DWR and on Twitchell Island through a partnership of DWR and Ducks Unlimited. These non-tidal inter-island wetlands provide high quality habitat that could support a giant garter snake population. Otherwise, it is largely unknown whether other reproducing source populations of giant garter snakes occur within the various wetland habitats of the Central and Western Delta. Focused surveys in these areas are hindered either due to inaccessibility to privately owned lands or lack of resources.

Colusa Basin Population

The Action Area includes the sub-population in the Colusa Basin Population and Recovery Unit as defined in the *Recovery Plan for Giant Garter Snake* (Service 2017). The Colusa Basin Recovery Unit is comprised of mostly agriculture lands predominantly in rice production which also include the Sacramento National Wildlife Refuge (NWR), the Delevan NWR, Glenn-Colusa Canal, Colusa Trough, Colusa Drain, and several wetland habitats between the towns of Chico and Woodland from north to south and between the western edge of the Sacramento Valley to the Sacramento River from west to east.

There are 81 records in the CNDDB (CDFW 2024) of giant garter snakes in the Colusa Basin Recovery Unit. The USGS has conducted trapping surveys of giant garter snakes at the Sacramento NWR Complex (Wylie *et al.* 1996, 1997, 2000, 2002b). Wylie, in conjunction with Refuge staff, observed giant garter snakes at each of the Federal wildlife refuges (Colusa, Delevan, and Sacramento) that comprise the Sacramento NWR complex. Wylie *et al.* (2000a, 2002a) located 81 and 102 giant garter snakes, respectively, in the years 2000 and 2001 within the Colusa NWR. It is also documented that giant garter snakes occur outside of NWR lands in the adjacent rice production areas. The Colusa NWR represents a stable, relatively protected sub-population of snakes within the Colusa Basin and continues to reflect a healthy population of giant garter snakes with successful recruitment of young (Wylie *et al.* 2003, 2004a, 2005).

Outside of protected areas, however, giant garter snakes in the Colusa Basin clusters are still subject to all threats identified in the final listing rule, including habitat loss due to development, fluctuations in the number of acres in rice production, maintenance of water channels, and secondary effects of urbanization. Restored areas that provided summer water were more effective in meeting the habitat needs of giant garter snakes; therefore, giant garter snakes did not have to venture as far as in previous years to find aquatic habitat during their active period. This was also found to be true for monitoring conducted during 2005. Sampling of the restored areas in Colusa NWR during the summers of 2002 and 2003 continued to document use of the restored wetland area as the habitat quality improves. The aquatic component of the habitat is important because the snake forages on frogs, tadpoles and fish. The 2005 Monitoring Report for the Colusa NWR (Wylie *et al.* 2005) concluded that, "The management of the Colusa Refuge for GGS, which began with the restoration of Tract 24, has clearly benefited the snakes in the restored wetlands and other habitats by maintaining and increasing stable summer water habitats for the snakes, maintaining connectivity among wetland habitats and carefully managing marsh vegetation." Stony, Logan, Hunters, and Lurline Creeks, as well as the Colusa Drain, and Glenn-Colusa, Tehama Colusa, and Colusa Basin Drainage Canals, and associated wetlands, are important as snake habitat and movement corridors for giant garter snakes. These waterways and associated wetlands provide vital permanent aquatic and upland habitat for snakes in areas with otherwise limited habitat (Wylie *et al.* 2005).

Butte Basin Population/Recovery Unit

The Butte Basin Recovery Unit encompasses the entire Butte Basin, extending from Red Bluff in the north to the Sutter Buttes in the south. The Butte Basin consists of 479,118 acres, including portions of Tehama, Butte, Sutter, and Colusa counties. Three management units have been defined for the Butte Basin Recovery Unit: Llano Seco, Upper Butte Basin, and Gray Lodge/Butte Sink. Most occurrences are located in the Upper Butte Basin Wildlife Area and the Gray Lodge Wildlife Area and are associated with rice fields. In addition, within the Butte Basin Recovery Unit, there are two important snake populations that occur within this unit (portions of Little Butte Creek, Butte Creek). Refer to the 2020 5-year review for occurrence and trapping data.

Sutter Basin Population/Recovery Unit

The Sutter Basin extends south from the Sutter Buttes to the confluence of the Feather and Sacramento rivers. The Sutter Basin consists of 239,810 acres, including portions of Butte and Sutter counties. Three management units have been defined for the Sutter Basin Recovery Unit: Sutter, Gilsizer Slough, and Robbins. Two important snake populations (portions of Willow Slough and Bypass, Sutter Bypass Toe Drain) are located within the Sutter Basin Recovery Unit. Refer to the 2020 5-year review for occurrence and trapping data.

American Basin Population/Recovery Unit

The American Basin extends south from Folsom Reservoir to the confluence of the Sacramento and American rivers. The Basin is about 376,104 acres, including portions of

Butte, Yuba, Sutter, Placer, and Sacramento counties. Four management units have been defined for the American Basin Recovery Unit: District 10, Olivehurst, Nicolaus, and Natomas Basin. The American Basin Recovery Unit contains the most known occurrences with the majority of these occurrences located in the Natomas Basin. The entire Natomas Basin is identified as an important snake population. Refer to the 2020 5-year review for occurrence and trapping data.

There are eight established giant garter snake conservation banks and preserves in the Action Area. The Colusa Basin Mitigation Bank has restored and conserved 163 acres for the giant garter snake, the Ridge Cut Giant Garter Snake Conservation Bank has restored and conserved 185.9 acres for the giant garter snake, the Sutter Basin Conservation Bank restored 407.55 acres of open water, perennial marsh, seasonal marsh, and upland habitat, Gilsizer Slough South Conservation Bank provides 379.4 acres of open water, perennial marsh, and upland habitat, Gilsizer Slough North Giant Gartersnake Preserve provides 145 acres of habitat, the Prichard Lake Preserve provides 42.7 acres of habitat, Willey Wetlands Preserve provides 217 acres of habitat, and the Pope Ranch Conservation Bank (which all credits have been sold and is inactive) has restored and conserved 391 acres for the giant garter snake.

Habitat has also been preserved, created, or restored in the Action Area as a result of section 7 consultations between the Service and other Federal agencies. Projects such as the Sherman Island Whale's Mouth Wetland Restoration Project (Service File No. 08FBDT00-2014-F-0027) restored approximately 600 acres of palustrine emergent wetlands and the Twitchell Island East End Habitat Restoration Project (Service File No. 08FBDT00-2013-I-0013) restored approximately 740 acres of palustrine emergent wetlands in the western portions of the Sacramento-San Joaquin Delta. There are various section 7 consultations with biological opinions for giant garter snake that occur throughout the Action Area. Large scale habitat restoration projects such as the Prospect Island Habitat Restoration Project (Service File No. 08FBDT00-2018-F-0069) and the Lookout Slough Habitat and Restoration Project (Service File 08FBDT00-2020-F-0181) will convert portions of terrestrial habitat that could be utilized by giant garter snake to aquatic habitats for fish species. The Corps dredges the Sacramento and Stockton Deep Water Shipping Channels annually and deposits the dredged material into landside placement sites throughout the Delta that have or are near suitable habitat for giant garter snake (Service File Nos. 08FBDT00-2017-F-0098, 08FBDT00-2017-F-0099). CDFW was issued a grant from the Service to conduct routine vegetation maintenance and to manage wildlife habitat for waterfowl and other species that utilize emergent wetland habitats throughout the YBWA. This requires the use of mowers and other large equipment to operate within suitable habitat for giant garter snake (Service File No. 08FBDT00-2012-F-0011) along with a subsequent reinitiation of the biological opinion for the issuance of another 5-year grant (Service File No. 2023-0042075-S7-001). Several flood protection projects such as the Twitchell Island Levee Improvement Project (08FBDT00-2015-F-0023) proposed to repair or build new levees that have or were near suitable giant garter snake habitat.

d. Effects of the Action

Giant Garter Snake Effects from Implementation of the Shasta Framework

Reclamation is proposing a new approach to managing Shasta which changes the balance between risks of flood control releases (i.e. spills) and maintaining water in storage for future drought protection and temperature management. This approach, described below, places a higher priority on maintaining storage for drought protection for all project purposes while limiting the frequency of spilling water due to flood control limitations.

The loss of wetland ecosystems and suitable habitat has resulted in the giant garter snake using modified habitats like agricultural fields. Located among cultivated farm lands, these areas include irrigation ditches, drainage canals, rice fields, and their adjacent uplands. Since giant garter snake surveys were first conducted in the 1970s, results have demonstrated that active rice fields and the supporting water conveyance infrastructure consisting of a matrix of canals, levees, and ditches have served as alternative habitat that is commonly used by the giant garter snakes in the absence of suitable natural marsh habitat (G. Hansen 1988; G. Hansen and Brode 1980, 1993; Brode and G. Hansen 1992; Wylie 1998a; Wylie *et al.* 1997a; Wylie and Cassaza 2000; Halstead *et al.* 2010).

Actions that prioritize maintaining storage in Lake Shasta for drought protection may affect giant garter snake. The primary mechanism for this effect is through actions that delay or shift spring diversions to maximize storage. Delaying or shifting diversions could preclude the ability of contractors to plant crops conducive for giant garter snake, particularly rice. Similar to the analysis in the *Rice Decomposition Smoothing* section below, delaying or shifting the timing of diversions may affect the ability of giant garter snake to use flooded rice fields. In the case of Shasta Framework implementation, this delay would occur in the spring, not the fall. Rice fields are typically planted and flooded beginning in April and would usually be available for giant garter snakes as they become active with the onset of warmer air temperatures and leave their overwintering hibernacula. Depending on the timing and amount of water diverted from the Sacramento River, rice fields might not be available when and where giant garter snake would typically utilize them.

Reduced diversions not only result in rice fallowing but also the reduction in the network of water-filled canals further reduce connectivity among populations, and in the near term might have stronger effects than urbanization on most giant garter snake populations (Halstead *et al.* 2021). Spring and summer rice production in the Sacramento Valley is important for the reproductivity of the giant garter snake as much of the historic emergent aquatic habitats in Sacramento Valley has been converted to agriculture (Service 2017). Giant garter snake young of the year require these aquatic habitats for sufficient cover from predators and primarily for prey availability. Prey such as small fish, smaller amphibians (such as tree frogs and bullfrog tadpoles), and invertebrates are more numerous in these shallow water environments and can provide giant garter snake neonates with sufficient prey base. The growth and survival rates of juvenile (1 year old) giant garter snakes also have an important influence on population growth, especially when the probability of recruitment from neonate to 1 year old is higher (Rose *et al.* 2019).

These effects would not occur but for the implementation of the Shasta Framework since under baseline conditions more water would have been released from Shasta and diverted for agricultural purposes. These effects would be largest in Bin 3B (approximately 9% of years) year types.

During the first ten years (2025-2035), the contractors would collectively incur a reduced contract supply of up to 500,000 acre-feet under their aggregated contracts during certain years if the following four conditions are met:

1. Forecasted end-of-April Shasta Lake storage is less than 3.0 MAF;

2. Forecasted end-of-September Shasta Lake storage is less than 2.0 MAF;

3. Combined actual and forecasted natural inflow to Shasta Lake from October 1 through April 30 is less than 2.5 MAF; and

4. Reclamation forecasts a Critical Year under the Settlement Contracts.

During the following ten years (2036-2045), the contractors would agree to incur a reduced contract supply of up to 100,000 acre-feet under their aggregated contracts collectively during certain years if the following two conditions are met:

1. Combined actual and forecasted natural inflow to Shasta Lake from October 1 through April 30 is less than 2.5 MAF; and

2. Reclamation forecasts a Critical Year under the Settlement Contracts.

These reductions and diversions are likely to result in cropland idling, crop shifting, groundwater substitution, and conservation. The acreage of cropland idling would be calculated based on water application to crops which consists of both consumptive and non-consumptive uses (U.S. Bureau of Reclamation 2024). The combination of these uses results in a total water application factor of about 6.0 - 7.0 acre-feet per acre, which when applied across the SRSC service area to the maximum 500,000 AF during the first ten years and the maximum 100,000 AF the following ten years, results in an annual maximum of 71,429 to 83,333 acres and 14,285 to 16,667 acres of rice fallowed (U.S. Bureau of Reclamation 2024). However, much of the acreage that may be fallowed is either unoccupied, not utilized, or currently unavailable for the giant garter snake.

When forecasting potential adverse effects from implementation of the Shasta Framework, there are several possibilities; however, the most likely adverse effects to individual giant garter snakes would occur in the form of mortality from exposure to predation (large fish, egrets, herons, and otters) that would otherwise not occur if agricultural fields in rice production were not fallowed or changed into a different crop type. Giant garter snakes require water during the active season of their life (May 1- October 1). For giant garter snakes that occur in the Sacramento Valley, ditches, canals, other agricultural conveyance features, and rice fields all provide suitable aquatic habitat for the snake. Rice fields in particular, provide additional aquatic habitat that snakes utilize for cover from predators and provide a prey base for foraging on fish and amphibians during their active season. Conveyance features and mature rice fields provide essential cover for the snake to escape from known predators that occur within these habitats. The loss of rice lands could increase snake mortality from predation if they are limited to reside exclusively in these conveyance canals and ditches. A reduction in rice production will likely make snakes relocate to other areas to find available foraging areas and giant garter snakes would likely be exposed to other predators such as raccoons, skunks, otters, coyotes, and raptors if giant garter snakes were forced into more dry upland terrestrial habitats with limited cover due to the lack of available emergent aquatic habitat or semi aquatic habitat such as rice agriculture.

Giant garter snakes would likely experience reduced fitness and fecundity as foraging and potentially breeding opportunities are reduced. Rice fallowing and reduction in the network of water-filled canals caused by the Shasta Framework and Bin 3b years further reduce connectivity among populations, and in the near term might have stronger effects than urbanization on most giant garter snake populations (Halstead *et al.* 2021). Spring and summer rice production in the Sacramento Valley is important for the reproductivity of the giant garter snake as much of the historic emergent aquatic habitats in Sacramento Valley has been converted to agriculture (Service 2017). Giant garter snake young of the year require these aquatic habitats for sufficient cover from predators and primarily for prey availability. Prey such as small fish, smaller amphibians (such as tree frogs and bullfrog tadpoles), and invertebrates are more numerous in these shallow water environments and can provide giant garter snake neonates with sufficient prey base. The growth and survival rates of juvenile (1 year old) giant garter snakes also have an important influence on population growth, especially when the probability of recruitment from neonate to 1 year old is higher (Rose *et al.* 2019).

The amount of rice fallowed could be reduced by the use of groundwater substitution, which could be used in lieu of surface water supplies. It is currently unknown to what extent this option may be available or utilized in any specific year..

The actions proposed in the Shasta Framework are similar to those under the Long-Term Water Transfers Project (2019-2024) (Service File Number 08ESMF00-2019-F-0619-1). Under the water transfer program, Reclamation monitors giant garter snake distribution and that occupancy research does not lapse. The research includes annual sampling of giant garter snake within the Action Area and focuses on their distribution and occupancy dynamics. The research is designed to evaluate the effectiveness of the conservation measures for occupancy at sites forgoing water. The research is ongoing since 2015 and is expected to aid in maintaining effective conservation measures for actions that may impact giant garter snake and identifying any changes that may enhance their effectiveness in the future.

In Reclamation's *2023 Annual Compliance Report for the Bureau of Reclamation's Central Valley Project Long-term Water Transfers (2019-2024)*, Reclamation concluded from review of the preliminary data from the USGS research effort, that there is no indication that water transfers are having unanticipated effects on giant garter snake, or that conservation measures associated with the Long-Term Water Transfers Project are ineffective. Since actions proposed under the Shasta Framework are similar to those proposed under the Long-Term Water Transfers Project, any adverse effects from the Water Reduction program are likely to be similar in degree.

Rice Decomposition/Smoothing

The Service does not anticipate that rice decomposition/smoothing would adversely affect giant garter snake. Rice decomposition/smoothing actions are proposed to begin in August. This would be at the end and typically the hottest and dryer part of the summer. Giant garter snakes would likely be sheltering from the heat in burrows and/or seeking more permanent bodies of water as the rice fields themselves are temporary aquatic habitats. As rice decomposition/smoothing actions for winter-run Chinook salmon proceed into the late fall and winter, giant garter snakes will have entered their brumation period around October where they seek underground shelter to brumate through the winter to reemerge in the spring around April and May, so those actions would not affect giant garter snakes already in underground shelter.

e. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect giant garter snake. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the giant garter snake.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the giant garter snake.

Reproduction

The giant garter snake is found in the Action Area and several occurrences have been documented from 2013 to 2018 in the western Delta (CDFW 2019; DWR 2015; Service 2019; Stillwater Sciences 2017) and giant garter snakes have been continuously documented throughout the Sacramento Valley (CDFW 2024; Service 2024). The PA may reduce local reproduction as disturbances from crop shifting/idling are likely to interfere with normal giant garter snake mating behaviors and fecundity. In areas that experience crop shifting/idling, it is anticipated that the crop shifting/idling would cause a reduction in reproductivity based on the reduction of available habitat; however, this is anticipated to result in loss of a relatively small number of giant garter snakes. It is anticipated that the effects will not reduce the range-wide reproductive capacity of the species.

Numbers

The bulk of the giant garter snake's population occurs in the Sacramento Valley with smaller populations located in the Delta and in the San Joaquin Valley (CDFW 2024; Service 2024). We anticipate the PA is likely to result in adverse effects to the giant garter snake, but the number of giant garter snakes that will be adversely affected within the relevant portion of the Action Area is unknown. However, we expect the number to be small in relation to the number of snakes in the remainder of its range and we conclude that the overall number of giant garter snakes throughout the species' range is not expected to decline due to the PA.

Distribution

The number of giant garter snakes likely to be affected by the PA is unknown but likely to be relatively small. The Service anticipates that the PA will not alter the distribution of the giant garter snake and we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of the giant garter snake, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of giant garter snake. We have reached this conclusion because:

- Based on the overall status of the species range-wide, the anticipated fraction of actual habitat temporarily affected through crop idling/shifting in the Action Area is relatively low.

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10. Longfin Smelt DPS

a. Status of the Species

The longfin smelt is a small, short-lived fish of the family Osmeridae. The Service proposed to list the San Francisco Bay-Delta DPS of the longfin smelt as endangered on October 7, 2022 (Service 2022), and the final rule listing the longfin smelt DPS as endangered published in the Federal Register on July 30, 2024 (Service 2024a). For the comprehensive assessment of the longfin smelt DPS, please refer to the proposed listing rule at https://www.govinfo.gov/content/pkg/FR-2022-10-07/pdf/2022-21605.pdf and the "Species Status Assessment for the San Francisco Bay-Delta Distinct Population Segment of the Longfin Smelt" at https://ecos.fws.gov/ServCat/DownloadFile/223002 (Service 2024b). As described in the final listing rule, a proposed designation of critical habitat for longfin smelt is in development and will be published in the near future.

The longfin smelt DPS has been in general decline for many decades due mainly to alterations of the estuary flow regime and food web (see Service 2024b for further details). A population viability analysis of the DPS indicated it had a high risk of quasi-extinction in the near future (2025-2040; Tobias *et al*. 2023). The Service is currently leading a life cycle modeling effort as part of the California Department of Fish and Wildlife's Longfin Smelt Science Plan that will be carried forward as part of the Adaptive Management Plan analyzed in this BiOp.

The longfin smelt DPS is a facultatively anadromous population (Table 10-1). Maturing adults migrate into low-salinity waters in the fall (increasingly, late fall). Current information indicates the annual spawning run(s) may be comprised of two dominant age-classes rather than only age-2 fish as was previously believed (Figure 10-1). Most spawning occurs from December-February (Table 10-1). Most if not all age-2 adults die after spawning (Figure 10-1). What fraction of the age-1 fish accompanying the older fish ends up spawning, and whether these younger fish survive if they do spawn, is not known. Some longfin smelt spawn in Suisun Bay and Marsh and parts of the Delta every year (Figure 10-2). When Delta outflow and Bay tributary flows are high enough, they can also spawn successfully in the Napa and Petaluma rivers and other Bay Area streams like the Coyote Creek watershed in South San Francisco Bay. In drier years, longfin smelt spawned in the South Bay tributaries do not appear to survive. After hatching, larvae and young juveniles have been collected across a wide range of salinities (Kimmerer 2002, his Fig. 10); albeit with a center of distribution near X2 (Dege and Brown 2004, their Fig. 3). As such, the spatial location of the age-0 population can vary considerably from year to year (Grimaldo *et al*. 2020, their Fig. 6; Gross *et al*. 2022, their Fig. 9; Figure 10-2). The survival of the age-0 cohorts is also correlated with the location of X2 and has historically been considerably higher in the wettest years compared to the driest ones (e.g., Kimmerer and Gross 2022, p. 2741). Survival was also found to be highest for individuals that had reared near X2 during four Wet and Above-Normal water years in which otolith microchemistry was evaluated (Hobbs *et al.* 2010, p. 557).

Figure 10-1: Length Frequency Histograms for Longfin Smelt

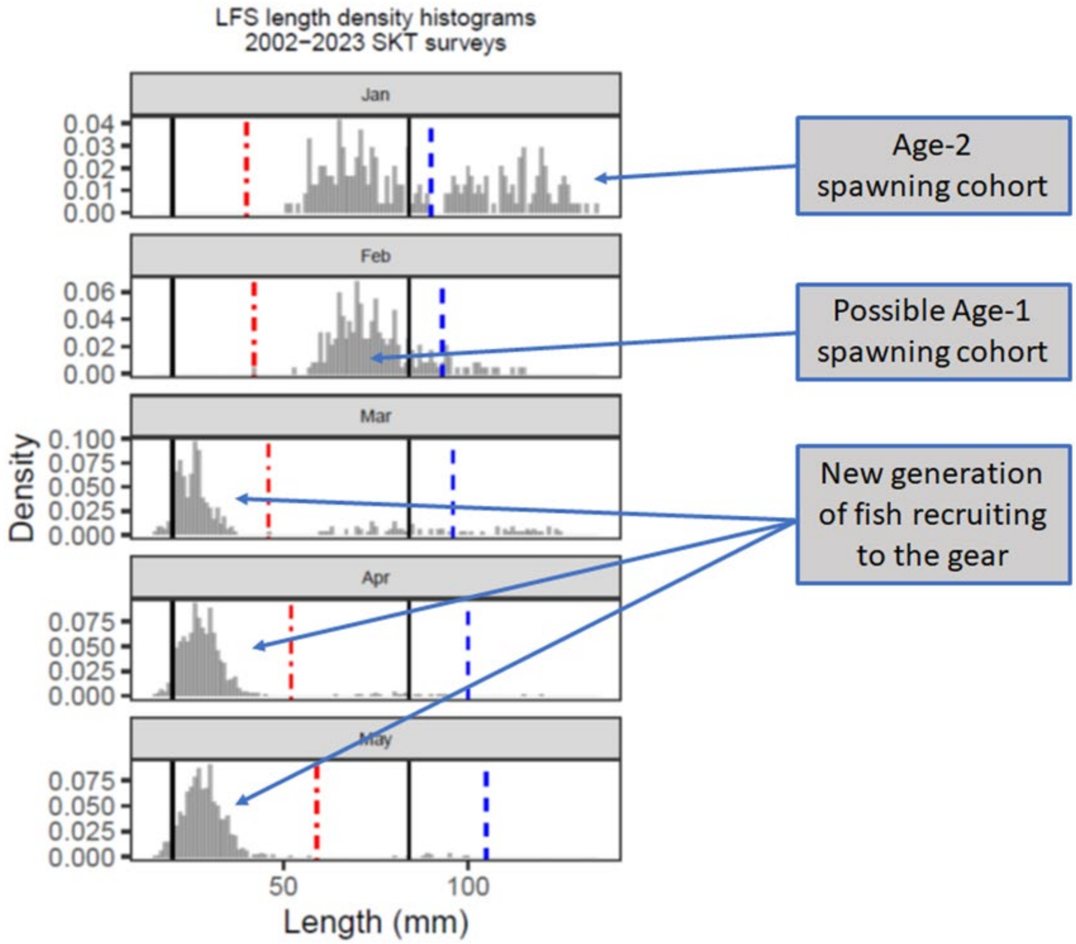


Figure 10-2: Conceptual Diagram Showing the Putative Differences in Spawning Locations

A center of distribution near X2 suggests longfin smelt larvae remain somewhat associated with aggregated sediment and phytoplankton that are passively retained in the vicinity of X2 by estuarine mixing currents (Jassby *et al*. 1995, pp. 274-275). Zooplankton distributions can also be concentrated near X2 but like fish larvae, zooplankton have some capacity to control their spatial distribution in areas where currents generated by mixing fresh- and saltwater provide cues and opportunities to facilitate aggregation despite limited swimming ability (Kimmerer *et al*. 2014, entire). Limited information on the habitat affinities of larval longfin smelt indicates catch densities are comparable in nearshore (mean depth ~ 2 m) and offshore habitats (mean depth ~ 11 m; Grimaldo *et al*. 2017, p. 1777). This suggests there is no strong affinity for water depth during the larval stage. Based on 3D hydrodynamic simulations, this indifference to water depth and aggregation within the low-salinity zone near X2 are expected outcomes for a weakly swimming planktonic animal (Kimmerer *et al.* 2014, entire). Larval longfin smelt generally have diets dominated by copepods (Jungbluth *et al*. 2021, pp. 1070-1071) but the larvae undergo an abrupt shift to a mysid-dominated diet when they reach ~ 25 mm in length (Barros *et al*. 2022, their Fig. 6). Some temperature thresholds for the longfin smelt DPS are shown in Figure 10-3 along with when and where they can be exceeded in the Delta and Suisun Bay.

As water warms in the later spring and early summer, the young fish move seaward to cooler, higher salinity habitats in San Pablo and San Francisco bays, and an unknown fraction of these now juvenile fish enter the Pacific Ocean (Young *et al*. 2024a, their Fig. 1). Thereafter, longfin smelt remain predominantly west of Carquinez Strait until some individuals return to lower salinity water in the fall. While in the estuary, these older longfin smelt are well-known to occupy tidal marsh habitats (e.g., Matern *et al*. 2002, their Table 2; Rosenfield and Baxter 2007, their Fig. 7C; Lewis *et al*. 2019, entire) and open-water pelagic habitats and shoals (Rosenfield and Baxter 2007, p. 1586; Mahardja *et al*. 2017, their Table 1 and Fig. 2; Young *et al*. 2024b, Figs. 3-4). However, they have only occasionally been reported from habitats in Suisun Marsh and the Delta that can be sampled via beach seine, meaning habitats with a water depth less than ~ 1 meter (Matern *et al*. 2002, their Table 2; McKenzie *et al*. 2024, their Table 1). Ocean habitat use is less well-characterized from a microhabitat perspective (Young et al. 2024a, entire).

Figure 10-3: Selected Longfin Smelt Temperature Information

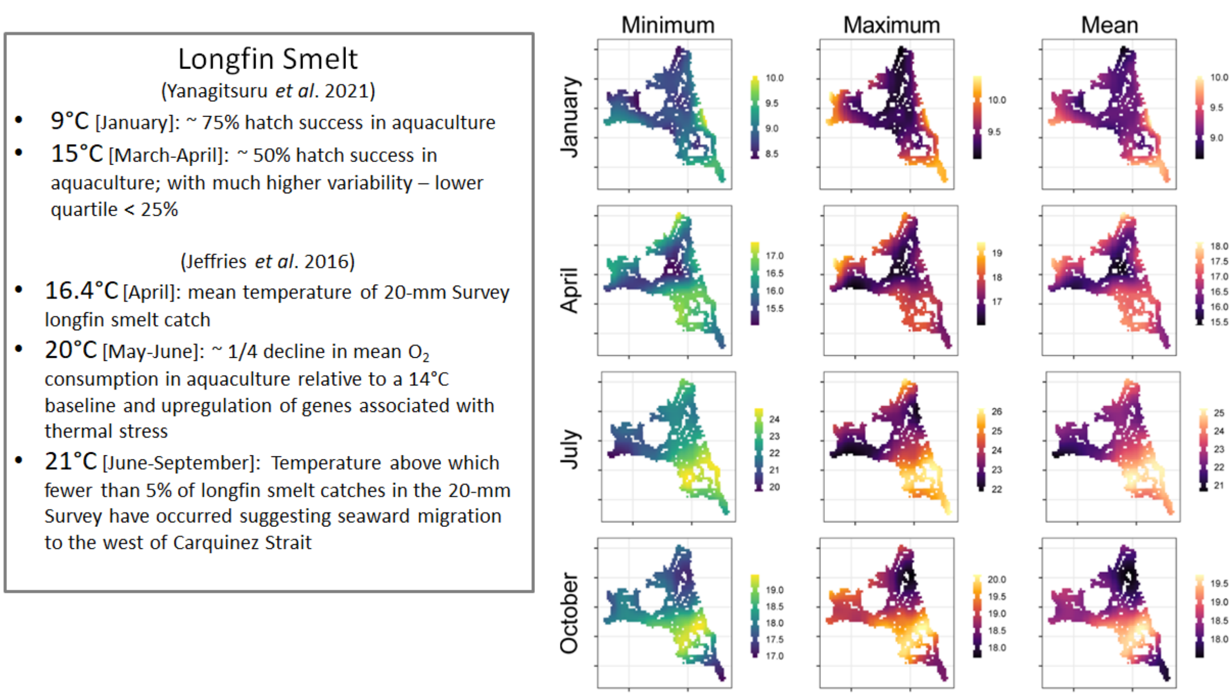


Table 10-1: Table summarizing the life cycle timing and survey observation information

Month	Life cycle timing of the spawning cohort(s) (~ age-1 and age-2 fish)	Life Cycle timing of each year's new cohort (age-0 fish)
December	Spawning begins anywhere in the estuary that conditions allow (Bay tributaries, estuary low-salinity zone, Delta; Gross *et al*. 2022, their Fig. 9) The precise spawning habitat requirements are unknown Some historical salvage was observed (Grimaldo *et al*. 2009a, their Fig. 5) but an adult longfin smelt has not been salvaged in December since 2007	Most individuals are in demersal, adhesive egg stage in fresh to low-salinity waters
January	Spawning continues Historical salvage peak (Grimaldo *et al*. 2009a, their Fig. 5); salvage in January was observed as recently as 2023	Egg incubation continues, larval emergence begins

Month	Life cycle timing of the spawning cohort(s) (~ age-1 and age-2 fish)	Life Cycle timing of each year's new cohort (age-0 fish)
February	Spawning continues Older cohort has largely perished (Figure) Typically, the last month of salvage; salvage in February was observed as recently as 2023	Egg incubation continues and larval emergence can reach its peak (Gross *et al*. 2022, p. 187)
March	Spawning concludes in all but the coolest years Younger cohort has largely perished or moved back to higher salinity water (Figure); salvage in March has been observed as recently as 2023	Egg incubation and larval emergence continue (inferred from Gross *et al*. 2022, their Fig. 9) Peak recruitment to the 20-mm Survey gear can occur in March (Melwani *et al*. 2022, their Fig. 15B) First observations in salvage (Grimaldo *et al*. 2009a, their Fig. 5); salvage in March has been observed as recently as 2022

Month	Life cycle timing of the spawning cohort(s) (~ age-1 and age-2 fish)	Life Cycle timing of each year's new cohort (age-0 fish)
April	Spawning has nearly always concluded; most spawners have died or moved back to higher salinity water (Rosenfield and Baxter 2007, their Fig. 8)	Egg incubation generally concludes as hatching success is temperature dependent and begins declining once temperature exceeds ~ 12°C (Yanagitsuru *et al*. 2021, their Fig. 1) Peak recruitment to the 20-mm Survey gear can occur in April (Melwani *et al*. 2022, their Fig. 15B) Peak historical salvage (Grimaldo *et al*. 2009a, their Fig. 5); salvage in April has been observed as recently as 2024
May	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean	20-mm Survey catches begin to drop, presumably due to a combination of mortality and migration into higher salinity water (Melwani *et al*. 2022, their Fig. 15B) Peak historical salvage continued (Grimaldo *et al*. 2009a, their Fig. 5); salvage in May has been observed as recently as 2022

Month	Life cycle timing of the spawning cohort(s) (~ age-1 and age-2 fish)	Life Cycle timing of each year's new cohort (age-0 fish)
June	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean	Surviving members of the cohort(s) begin rearing predominantly in higher salinity waters including the Pacific Ocean Historical salvage declined to near zero (Grimaldo *et al*. 2009a, their Fig. 5) Salvage in June has not been observed since 2013
July	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean
August	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean
September	Some surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean but others begin re-occupying low-salinity waters	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean; some individuals begin re-occupying low-salinity waters
October	Some surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean but others begin re-occupying low-salinity waters	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean; some individuals begin re-occupying low-salinity waters

Month	Life cycle timing of the spawning cohort(s) (~ age-1 and age-2 fish)	Life Cycle timing of each year's new cohort (age-0 fish)
November	Some surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean but most putative spawners begin re-occupying low-salinity waters in preparation for spawning	Surviving members of the cohort(s) continue to rear in higher salinity waters including the Pacific Ocean; some individuals begin re-occupying low-salinity waters, possibly in preparation for spawning

b. Status of the Critical Habitat

Critical Habitat has not been proposed for the longfin smelt DPS.

c. Environmental Baseline

The Environmental Baseline describes the past and present impacts of all Federal, State, or private actions and other human activities in the Action Area, the anticipated impacts of all proposed Federal projects in the Action Area that have already undergone formal or early section 7 consultation, and the impact of State or private actions, which are contemporaneous with the consultation in process (50 CFR 402.02). The key purpose of the Environmental Baseline is to describe the condition of the listed species and its critical habitat that exists in the Action Area in the absence of the action subject to this consultation. In this way, it provides a starting point for identifying effects of the action.

The effects of past CVP/SWP operations are part of the Environmental Baseline. Those effects have undergone consultation and contributed to the current condition of the species and critical habitat in the Action Area. Other past, present, and ongoing impacts of human and natural factors (including proposed Federal projects that have already undergone section 7 consultation) contributing to the current condition of the species and critical habitat in the Action Area are included in the Environmental Baseline for section 7 consultation purposes. A description of previous actions that have contributed to these current conditions are described in Section 2.5 of the Environmental Baseline chapter of the BA.

The following information supplements and updates the information provided in Section 2.5 of the Environmental Baseline chapter of the BA:

Agricultural Barriers installation:

The Service completed a section 7 consultation on the installation of these barriers for years 2023 through 2027 on March 10, 2023 (Service File Number: 2023-0004507-S7-001). The ongoing effects to hydrodynamics from the presence of the three temporary agricultural barriers was included in the LTO modeling (referred to as South Delta Temporary Barriers in Appendix F: Modeling Section 1-1, CalSim 3, DSM2 and HEC5Q Modeling Simulations and Assumptions). The modeling that is relied upon in the analysis in this LTO BiOp included the following installation dates:

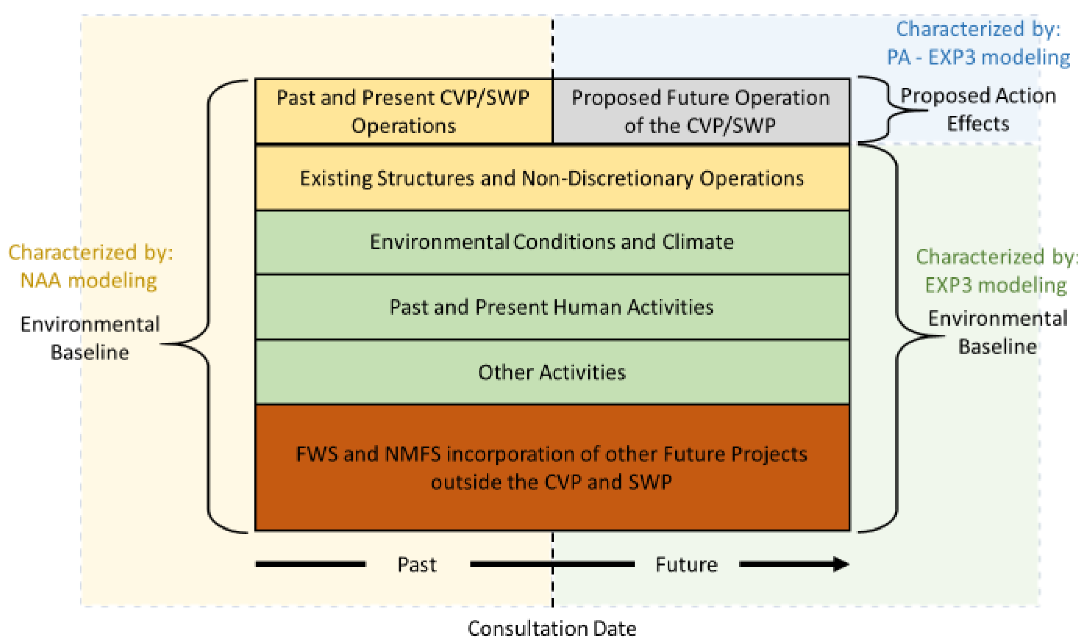
> *South Delta Temporary Barriers are operated based on San Joaquin flow conditions. The agricultural barriers on Old and Middle Rivers are assumed to be installed starting from May 16 and the one on Grant Line Canal from June 1. All three agricultural barriers are allowed to operate until November 30. The tidal gates on Old and Middle River agricultural barriers are assumed to be tied open from May 16 to May 31. Head of Old River Barrier would not be installed.*

Monitoring for the longfin smelt DPS

The Service completed a programmatic biological opinion on the effects of IEP activities to the longfin smelt DPS on August 22, 2024 (Service File No. 2024-0052290-S7-001). This programmatic biological opinion addresses the effects of long-term monitoring and special studies throughout the San Francisco Estuary using numerous fishing gear types that are placed in the water, as well as broodstock collection of this species. The IEP's monitoring programs and other long and short-term studies provide valuable information on the ecological function of the estuary including relative abundance trends for numerous fish species and their supporting food resources within the Action Area. The special studies have a variety of goals that have varied substantially over time but some of them intend to target longfin smelt to answer questions about the DPS' life history, distribution, or vital rates.

As described in the definition above, the impacts from Federal agency activities or existing Federal agency facilities that are not within the agency's discretion to modify are part of the environmental baseline. This component is depicted as "Existing Structures and Non-Discretionary Operations" in Figure 10-4 below. As depicted, these impacts have occurred in the past and will continue to occur into the future. Therefore, they form part of the foundation from which the effects of the proposed action are added to inform our analysis as described in our *Analytical Framework for the Jeopardy Determination* and *Analytical Framework for the Adverse Modification Determination.*

Figure 10-4: Environmental Baseline



Modeling of the Environmental Baseline

The hydrologic and hydrodynamic modeling studies described above in the *Consultation Approach* section provide context for how the existence of the CVP and SWP facilities have affected and continue to affect the Environmental Baseline, including habitat conditions for species and critical habitat in the Action Area. Consistent with past consultations on the operations of the CVP and SWP, the dams and other existing project facilities are included in the Environmental Baseline.

As described in our Analytical Framework for the Jeopardy Determination and Analytical Framework for the Adverse Modification Determination for this consultation, our analysis includes factors responsible for the range-wide condition of the longfin smelt DPS. In *Appendix E - Exploratory Modeling* of the BA, Reclamation analyzed several modeling runs that depict CVP and SWP operations under different operational assumptions. The Exploratory Modeling runs provide context as to how operations have contributed to the current condition of the species and critical habitat.

The remainder of the Environmental Baseline is made up of all other factors leading to the current condition of the species and critical habitat. This includes how past and present CVP and SWP operations have led to the current condition. These past operations include modifications from operational criteria and obligations, such as the TUCOs that have resulted from TUCPs. The totality of past factors was modeled as closely as can be by Reclamation in the NAA. These additional factors are depicted in Figure 10-4 above.

The Environmental Baseline does not include the effects of the action under review in the consultation. In this case, the effects of the action are those resulting from the coordinated operations of the CVP and SWP. The timeframe for the quantitative modeling that supports this 2024 consultation is 2022±15 years (based on the 2022 median climate change scenario). Therefore, the quantitative portion of our effects analysis in this BiOp is limited to this timeframe. Effects of the action not captured by the quantitative modeling will be addressed qualitatively.

See the *Environmental Baseline* section in the delta smelt chapter for a general discussion of food web changes over time in the San Francisco Bay-Delta.

Since the longfin smelt was listed under CESA in 2009, the SWP has implemented measures to minimize the effects of their water operations which has resulted in reduced entrainment levels that have not been substantial enough to affect the species population dynamics and have been an effective conservation strategy for this species in the Bay-Delta (Service 2024b). The results of two different analytical approaches to the Smelt Larval Survey (SLS) data suggest that it is not likely that population-level entrainment of larvae has exceeded 3% since 2009 (Wim Kimmerer, pers. comm. as cited in Service 2024b). In addition, CDFW, DWR, the State Water Contractors and the Service have partnered to design and implement the Longfin Science Plan which was published in 2020. This plan contains seven priority science areas that are and will continue to be implemented to inform management decisions for the DPS and is included in this consultation as an Adaptive Management Action.

The Action Area for this consultation encompasses the entire range of the longfin smelt DPS. Therefore, we have merged the *Status of the Species* and the *Status of the Species within the Action Area* sections to fully address the range-wide status.

d. Effects of the Action

This section analyzes components of the PA that are likely to affect the longfin smelt DPS as summarized in the attached Effects Tracking Table. The action elements that are likely to affect the longfin smelt DPS occur in the upper estuary (Suisun Bay/Marsh and the Delta) where the species occurs seasonally. Monitoring activities could have effects extending throughout the estuary and possibly in the adjacent coastal ocean. Action components that occur in the non-tidal reaches of the Delta's watershed are not analyzed because any effects of those actions should be captured in our analysis of the various flow conditions in the estuary. The effects analysis is generally qualitative except where it relies on quantitative information provided in the BA or the literature. The hydrologic modeling involves considerable parsing of how different opportunities and constraints on operations (climate, end users, environmental regulations) interact to affect the estuary's flow regime, which allows for considerable insight into baseline effects stemming from cumulative system change over the past 170 years and our ability to separate those effects from effects anticipated to result from the water operations and other actions described in the PA, particularly as it relates to Delta outflow.

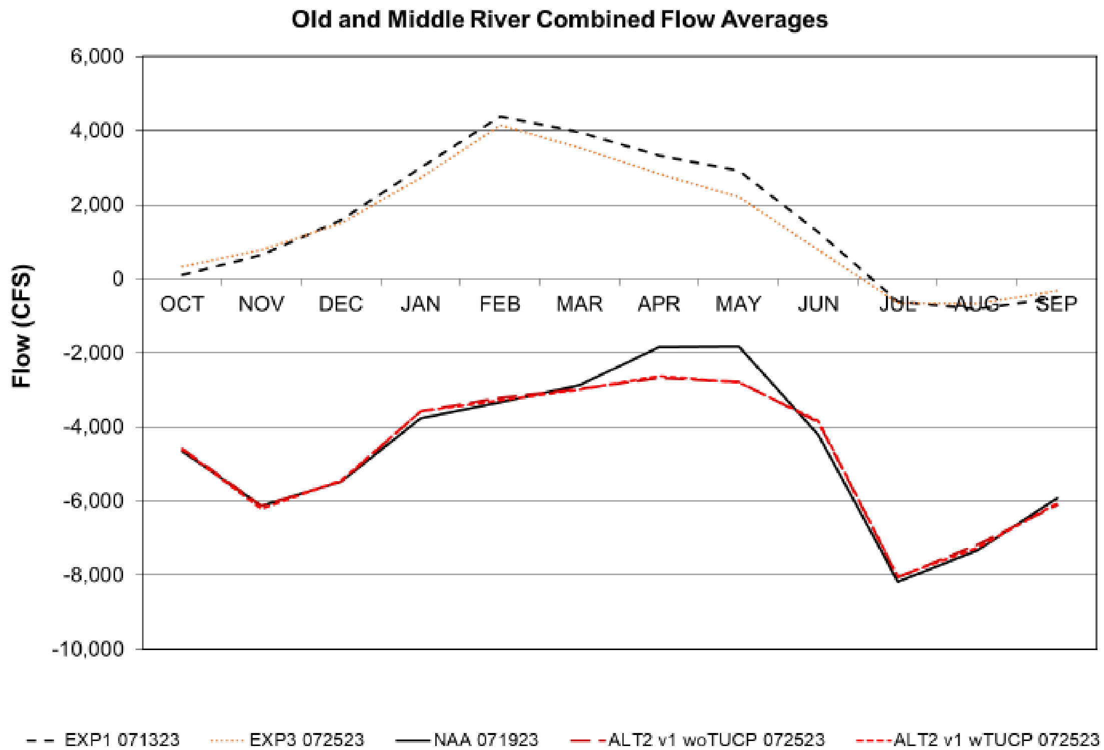
OMR management/Seasonal Operations (December through June)

The PA includes multiple OMR management actions intended to protect listed fishes from entrainment (BA *Section 3.7.4*). The entrainment of the longfin smelt DPS during water exports is defined by the movement of a fraction of the population into the South Delta, where they have little chance of successfully contributing to a subsequent generation. The suite of OMR management actions includes some specifically tailored to longfin smelt that can start as early as December 1 of each water year (BA *Section 3.7.4.4.1*) and end as late as the following June 30 (BA *Section 3.7.4.7*). These proposed operations will not eliminate entrainment of the longfin smelt DPS, but they should help to keep it similar to the low levels that have occurred since 2009 when OMR management rules first came into full effect (Figure 10-5).

The inclusion of a comprehensive OMR management strategy in the PA will be very protective of the longfin smelt DPS for a simple reason. Although there is overlap in the spatial distributions of the longfin smelt DPS and delta smelt during the winter and spring, the *average* location of the longfin smelt DPS is seaward of the *average* location of a delta smelt (e.g., Dege and Brown 2004, their Fig. 3). This means that at the scale of these two somewhat co-occurring fish populations, any given OMR will be more protective of the longfin smelt DPS than delta smelt, not because of OMR but because proportionally more of the longfin smelt are outside of the hydrodynamic influence of the Banks and Jones pumping plants. The following effects analysis reviews the evidence that supports this general conclusion.

Figure 10-5: Monthly average Old and Middle river flow from CalSim3 modeling. Figure taken from BA Appendix I: Old and

Middle River Flow



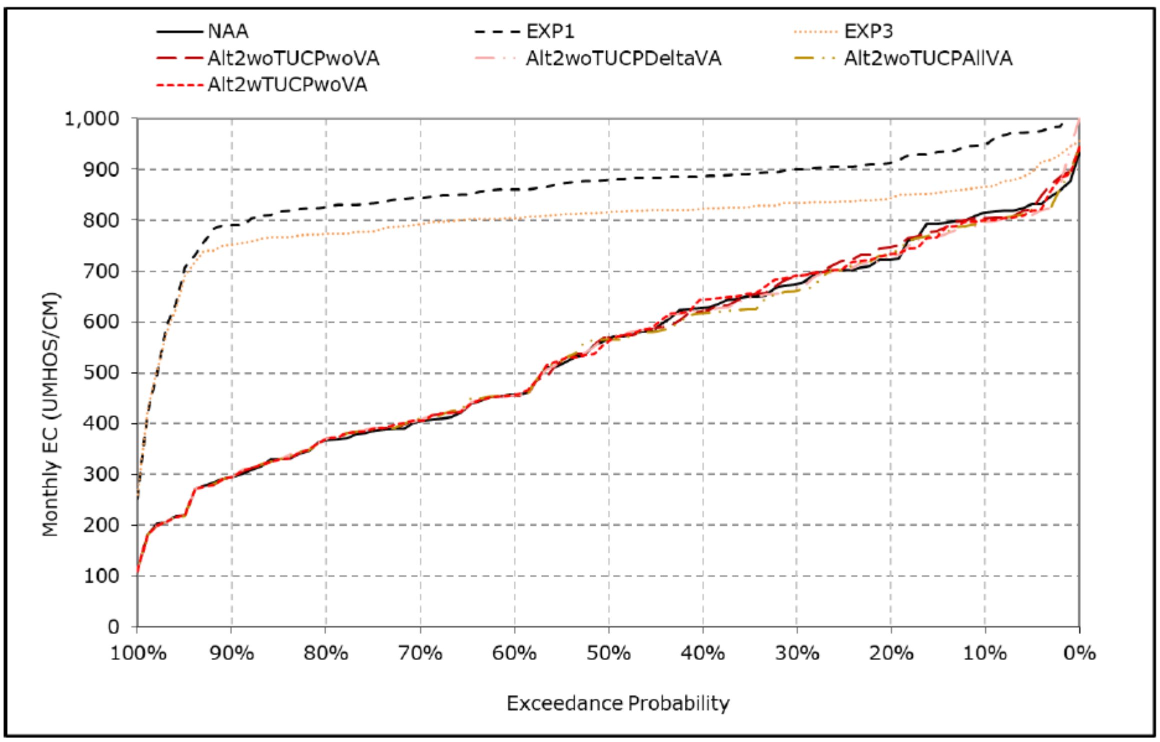
<u>Subadult and adult life stages</u>

Subadult and adult longfin smelt (individuals that are age-1 or older as of January 1) that had been residing in San Francisco Bay or the coastal ocean migrate back into the upper estuary in the fall and winter; some of those individuals spawn soon thereafter (Service 2022, p. 15; Table 10-1). Most of these returning individuals remain in or seaward of the low-salinity zone (CDFW 2020, their Fig. 2) and are now thought to predominantly spawn there (Gross *et al*. 2022, p. 193). The low-salinity zone is mobile and defined by a salinity range of about 0.5 to 5.0 psu or 0.5 to 6.0 psu. The low-salinity zone moves downstream (seaward) when Delta outflow is high and upstream (landward) when outflow is low. As a result, putative spawning areas for longfin smelt also move seaward when Delta outflow is high and landward when it is low (Grimaldo *et al*. 2020, their Fig. 6; Gross *et al*. 2022, their Fig. 9). The low-salinity zone can extend into San Pablo Bay when outflow is high and reach into the Delta when outflow is low. Salinities of 0.5 psu may at times extend as far as the

Banks and Jones pumping plants (Figure 10-6); however, the Projects avoid exporting saline water by adjusting their operations. Only under rare circumstances would the 0.5 psu edge of the low-salinity zone (~ 900 µMHOS/cm) intrude that far into the Delta. Note that the salinity range defining the low-salinity zone is an approximate description of a dynamic habitat, and longfin smelt are collected across a wider range of salinity in the fall and winter. Thus, episodic take from entrainment into the pumping plants of age-1 and older longfin smelt is anticipated to occur as it has in the past (Table 10-1).

Figure 10-6: Exceedance Plot of January Specific Conductance Expected at Banks Pumping Plant

Figure F.2.5-17-7. Banks Pumping Plant South Delta Exports Salinity, January EC



*All scenarios are simulated at 2022 Median climate condition and 15 cm sea level rise.

Age-1 and older longfin smelt can be entrained by the Banks (SWP) and Jones (CVP) pumping plants when they move into the Delta to spawn (CDFW 2020, p. 15). Some entrained longfin smelt are intercepted ("salvaged") at the fish facilities. Both fish facilities use louver systems designed to guide entrained fish into holding tanks so they can be separated from water headed toward the pumping plants. The fish that are separated this way are placed into trucks and returned to the Delta, which is what the term 'salvage' refers to. However, the behavioral guidance provided by the louvers is inefficient for small species like longfin smelt so many individuals may pass through and continue toward the pumping plants. Further, longfin smelt that are salvaged are considered unlikely to survive transport and release back into the Delta (CDFW 2020, their Table 1). Most historical salvage of age-1 and older longfin smelt has occurred in January and February, the peak spawning months for the DPS (CDFW 2020, their Fig. 13; Table 10-1).

The Service downloaded salvage data from SacPas (https://www.cbr.washington.edu/sacramento/workgroups/delta_smelt.html#opshyd) and compared the historical salvage of age-1 and older longfin smelt during December-March to the concurrent salvage of delta smelt (Figure 10-7). The salvage of delta smelt was higher due to its more inland distribution as mentioned above. Further, during water years 1994-2024, CDFW's Fall Midwater Trawl abundance indices were usually higher for longfin smelt than delta smelt. Thus, when considered as ratios of salvage to the FMWT index longfin smelt values were typically two orders of magnitude lower than the delta smelt equivalents and had to be plotted on a logarithmic scale for the ratios to be visible (Figure 10-8). This supports the hypothesis that the quantitative effect of entrainment is substantially lower for age-1 and older longfin smelt than it is for the concurrently entrained delta smelt. Salvage of age-1 and older longfin smelt has been infrequent since OMR management came into full effect in 2009; non-zero values during December-March have only been reported four times since 2009: 2011, 2013, 2019, and 2023. As was explained for delta smelt, this likely reflects a combination of declining abundance following drought years and OMR management, but overall, take of adult and pre-spawning juvenile longfin smelt at the Banks and Jones pumping plants appears to be a very minor source of loss.

Figure 10-7: Time Series of Delta Smelt And Longfin Smelt Salvage During the Winter

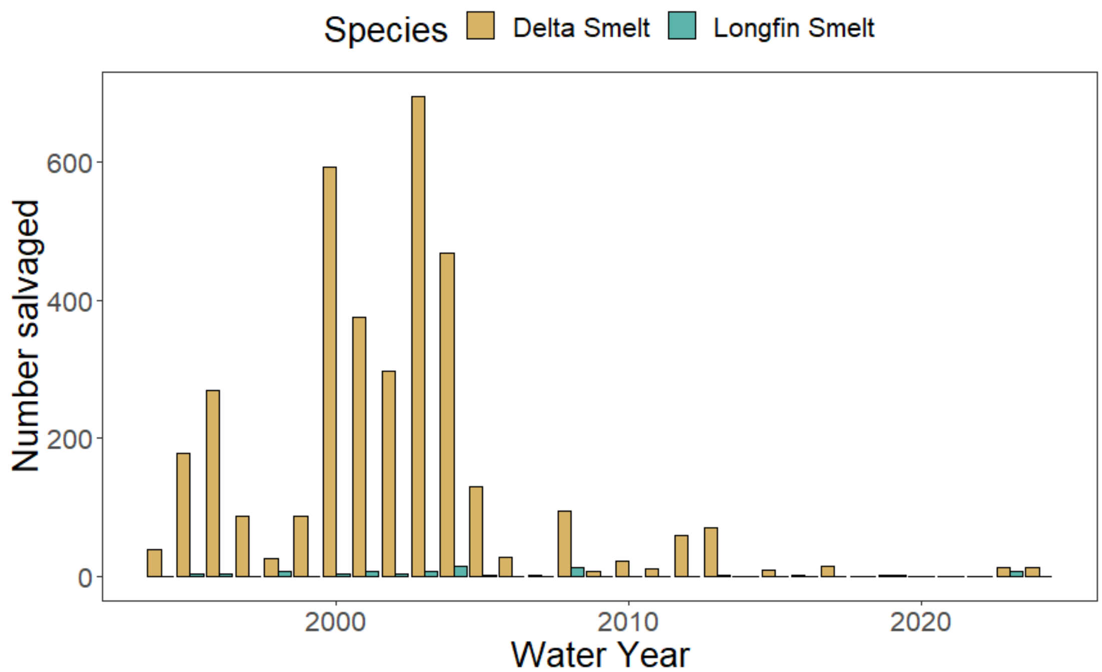
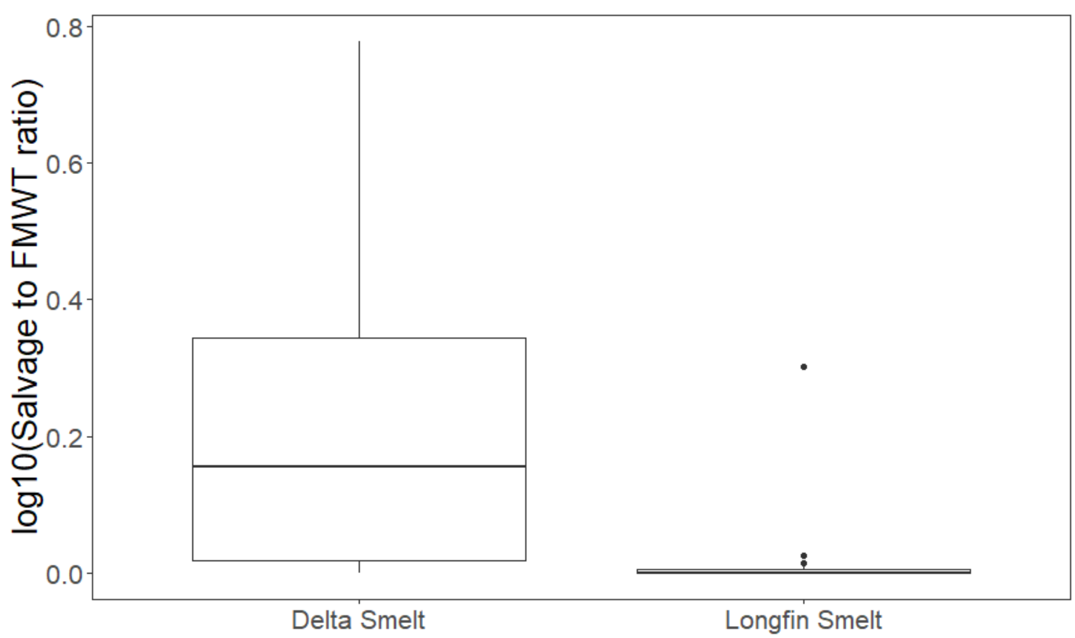


Figure 10-8: Boxplot Summarizing the Ratios of Subadult and Adult Salvage Relative ao Fall Midwater Trawl Abundance Index for Delta Smelt and Longfin Smelt



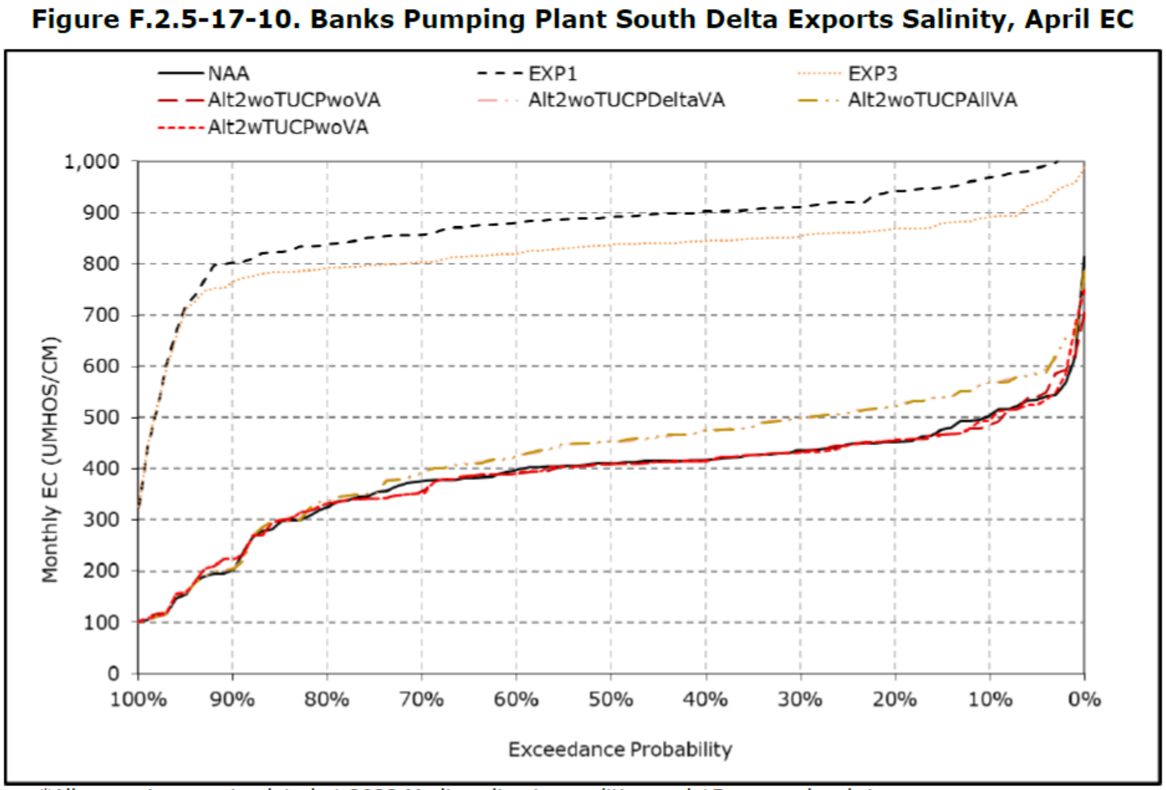
Larval and juvenile life stages (March through June)

Longfin smelt larvae hatch predominantly from within the low-salinity zone and become part of the plankton community both within the low-salinity zone and to a lesser degree, in adjacent lower and higher salinity habitats. Larval longfin smelt can also hatch from tributaries to San Francisco Bay when flows out of those tributaries are high (Lewis *et al*. 2021 p. 3; Gross *et al*. 2022, p. 187). Larvae hatching from these tributaries are not vulnerable to exports from the Delta. To be vulnerable to entrainment in exported water, the larvae have to either have been spawned in the South Delta or transported there by a combination of tidal and net river flow currents (Gross *et al.* 2022, entire).

Thus, the age-0 longfin smelt that reach the fish facilities are the tail of a statistical spatial distribution that is centered in the low-salinity zone (Eakin 2021, his Figure 2; Kimmerer and Gross 2022, their Fig. 3). The salvage of these age-0 (post-larval and juvenile life stage) fish is the most concrete evidence of take via entrainment; however, salvage of these life stages is even less efficient than it is for subadults and adults (CDFW 2020, their Table 1). As a result, a large majority of age-0 take goes unobserved, especially during January-March when many fish are still too small to be salvaged (e.g., CDFW 2020, their Figs. 3 and 13). Specifically, observations of longfin smelt less than 20 mm in length are for all intents and purposes, zero except via special larval fish surveys (CDFW 2020, their Table 4). Nonetheless, it is these 'invisible' larvae that are thought to be entrained at the highest rate given their average spatial distributions in survey data (it is the early larval stages that have the greatest overlap with freshwater habitats in the Delta; Kimmerer and Gross 2022, their Fig. 3). Salvage of the slightly older post-larvae that can be observed (≥ 20 mm or so) historically peaked in April and May but some individuals reached this size in March and some individuals were salvaged as late as June (Table 10-1). However, longfin smelt have not been seen in salvage during June since 2013, after which larval abundances declined notably (Eakin 2021, his Fig. 2). This decline presumably lowered their probability of detection.

The quantitative effect of entrainment on larval longfin smelt was recently evaluated using two methods (Gross *et al*. 2022, all; Kimmerer and Gross 2022, all). These authors focused on the larval life stage because larvae have the highest relative abundance in the South Delta of any longfin smelt life stage (Kimmerer and Gross 2022, p. 2731 and their Fig. 3). Kimmerer and Gross (2022) estimated that entrainment could reach about 0.5 percent of the population per day under very low flow conditions and would asymptote toward 0 percent as outflow pushes X2 (their Fig. 9A) and the landward edge of the low-salinity zone (Figure 10-6) downstream. These authors' cumulative effect of entrainment calculation is sensitive to the time interval it is estimated over but during 2009-2020, water export from the South Delta was estimated to take 0.3 to 1.6 percent of the larval longfin smelt population per year if 6.8 days was the correct accumulation period and up to 0.5 to 2.9 percent if 13 days was the correct accumulation period (Kimmerer and Gross 2022, their Table 1). Gross *et al*. (2022, their Fig. 11) used a 3-D particle tracking based approach to estimate the loss of larval longfin smelt in 2013 (a dry year) and 2017 (a wet year). They concluded it was highly unlikely more than 3 percent of larvae were entrained in 2013 and no more than 0.15 percent in 2017. These proportional entrainment estimates should probably be considered minimum estimates because they do not include post-larvae and young juveniles that are visible in samples of salvaged fish and because of the assumption that 'natural' mortality rates in the South Delta are the same as other parts of the ecosystem. The authors did not have an empirical basis to make a different assumption, but if mortality in the South Delta is higher than elsewhere, then more fish are transported there than the monitoring data indicate, and proportional loss would in turn be higher.

Figure 10-9: Exceedance plot of April specific conductance expected at Banks Pumping Plant



*All scenarios are simulated at 2022 Median climate condition and 15 cm sea level rise.

As mentioned above, age-0 longfin smelt can continue to be entrained after they exceed 20 mm in length at which time they can be observed and counted in salvage. This occurs because some larvae in the South Delta grow to an observable size before they reach the fish facilities. Hydrodynamics modeling has shown that under combinations of low Delta inflow and low exports (e.g., drought), particles can move around the Delta for months without moving either seaward to Suisun Bay or being lost to diversions (Kimmerer and Nobriga 2008, their Figs. 3-4). This mechanism likely explains the relatively high juvenile salvage in the recent drought spanning water years 2020-2022 (BA *Chapter 10, Table 1*). Most of this 'visible' loss occurs in April and May (Grimaldo *et al*. 2009a, their Fig. 5). There are no current reliable estimates for what additional fraction of each year's age-0 population is lost after it can be observed in fish salvage, but it is lower than what was estimated for larvae (Kimmerer and Gross 2022, their Fig. 3B vs 3A) and OMR management helps minimize it (Grimaldo *et al*. 2009a, their Fig. 7; and Kimmerer and Gross 2022, their Table 1).

Based on our analysis of the PA and its predicted effects we conclude:

- entrainment loss is anticipated to be very low for age-1 and older longfin smelt;
- entrainment loss is anticipated to seldom if ever exceed about 3 percent of the larval population; and
- entrainment of age-0 (juvenile) longfin smelt greater than or equal to 20 mm in length is anticipated to be minimized by the multispecies collection of OMR management strategies that apply in April and May.
- The entrainment levels analyzed and summarized above indicate that entrainment of the longfin smelt DPS is a minor source of loss and at proposed OMR levels, would not be likely to meaningfully change the species' population trajectory for better or worse (Kimmerer and Gross 2022, p. 2742).

Real-time operations

Kimmerer and Gross (2022, their Table 1) estimated "daily loss" of longfin smelt larvae in exported water which sounds like a potentially useful metric for gaging the effectiveness of real-time water operations. However, there are a couple of reasons it is not. First, only the export rate part of the calculation is actually founded in daily time-step data; the fish part of the loss calculation relied on the Smelt Larva Survey (SLS) which is on a bimonthly time-step, completing one survey every two weeks from January through March. The authors used those bimonthly data to estimate the abundance of larvae in the South Delta, assumed a daily mortality rate due to natural factors affecting all larvae everywhere and then used DAYFLOW's daily estimates of water export to estimate a daily export-driven entrainment mortality rate that dynamically interacted with the constant natural mortality assumption. This step was repeated for the five to six SLS sampling events each year and then an average of all the daily loss calculations (i.e., a three-month average) was reported as each year's "daily loss" in [pasted Table]. Thus, there is a dynamic daily hydrodynamic effect on the calculations (combined CVP and SWP exports) and a dynamic bimonthly population observation (larval longfin smelt abundance in the South Delta). Many combinations of daily exports and bimonthly larval abundances could result in the same three-month average; furthermore, larval abundance is difficult to measure and associated with high observation error, especially at the low fish densities of recent years. The expected weekly change in this 'daily' loss calculation could be estimated to compare short-term alternative operations scenarios each week, but the cumulative uncertainty of a longer-term twelve-week larval entrainment 'season' would likely be greater than what was reported by the authors (their Fig. 8). Projected losses would also need to include uncertainty in future abundances and Delta hydrodynamics, which were not needed in a retrospective analysis. Further, the relationship is simple: lower exports will always predict lower loss under any non-zero abundance in the South Delta. Kimmerer and Gross (2022, p. 2742) ended their paper with this statement:

> Finally, both this paper and Gross *et al*. (in review), which used the same data but very different methods, showed the cumulative proportional losses of longfin smelt to diversions to be small in comparison to the 100-fold dynamic range of the population index. This finding indicates that attempts to reverse the decline of this species through manipulation of diversion flows are unlikely to bear fruit.

The ESA requires evaluation of the likelihood of take of individuals as well as projected population-level effects. But that said, Kimmerer and Gross' point is noted. The PA includes numerous OMR actions tailored to multiple affected species and life stages (BA *Section 3.7.4*) and it continues to leave space for regular meetings of the Smelt and Salmonid Monitoring Teams, though no meeting interval is specified (BA *Section 3.13.3.4.2*). Based on the generally low entrainment loss of longfin smelt as reviewed above, the Service believes that take will be minimized via the broad application of OMR management, and we do not think weekly input from the Smelt Monitoring Team will be necessary for regulation of the longfin smelt under the ESA. However, there may be unforeseen circumstances or atypical catch or salvage patterns that occur periodically. If this happens the Service may seek input, insight, or advice from the Smelt Monitoring Team.

Barker Slough Pumping Plant

Most hatching of larval longfin smelt occurs in January and February with peak recruitment to post-larval life stages occurring in April and May (Table 10-1). The BSPP is a part of the SWP that has been in operation since 1988. It diverts water from Barker Slough in the Cache Slough Complex and delivers it to Travis Air Force Base, Napa County, and the cities of Vallejo and Benicia via the North Bay Aqueduct (BA Section 3.7.13). The diversions sit at the upstream terminus of Barker Slough, a dead-end slough in an area of very low natural inflow. As a result, flow in Barker Slough is frequently net negative, meaning it is usually moving toward BSPP. The facility has a maximum diversion rate of 175 cfs, theoretically allowing for a little more than 125,000 acre-feet (125 TAF) of water to be diverted annually (BA Section 3.7.13.1). The PA says design capacity limits BSPP diversion to 26 TAF during January through March. Capacity then increases to 42 TAF during March through June. If BSPP pumped 175 cfs for all of January through March, it could divert about 31 TAF so it is not clear what limits this by 5 TAF. The March through June number is the theoretical maximum pumping output; 175 cfs daily for the 122 days in March through June would generate just over 42 TAF, so this is not a limit of any kind. The PA includes BSPP pumping limits of 60 to 100 cfs to protect delta smelt in Dry or Critical water year types if certain catch triggers based on 20-mm Survey sampling are met or exceeded (BA Section 3.7.13.1.4).

DWR sampled fishes entrained through the BSPP fish screens during January-June of 2015 and 2016. Measured average approach velocities were usually ≤ 0.4 $ft \cdot s^{-1}$ and were usually slower near the water surface than at depth (DWR 2017 and 2019, Fig. 12 in both reports). Fish were pumped from the bays behind the fish screens into a large portable tank, then subsequently pumped through a 500-micron larval fish net to concentrate the catch (DWR 2017, their Figs. 16-18). The sampling collected 4,223 fish in 2015 (DWR 2017, p. 20) and 2,026 in 2016 (DWR 2019, p. 20). A large majority in both years were collected during ‘regular’ sampling, but some individuals (4-6%) were collected while the fish screens were being cleaned. Most of the individual fishes collected were 6-8 mm in length (see Figure 8-14); the largest fish collected was 26 mm, very near the design criterion expectation of 25 mm. No longfin smelt were collected in either year (DWR 2017, their Table 2; DWR 2019, their Table 2). We note that by the time of the DWR sampling, larval longfin smelt abundance in the CSC notably declined (Eakin 2021, his Fig. 2).

The PTM experiment the Service conducted to support the effects analyses for BSPP was described in Chapter 8 Delta Smelt, Barker Slough Pumping Plant. It is also the basis for the effects analysis for the longfin smelt DPS except that we did not have the detailed larval growth and mortality rate information for longfin smelt so the analysis is limited to interpretation that can be supported by PTM.

The PTM results predicted high spatiotemporal variability in the transport of particles to BSPP and agricultural diversions (range = 0 to 100%; Figure 8-17). Particles released closest to BSPP (node 325) were usually assured of being entrained into it. Particles released at the next closest node (326) also had a high predicted risk of entrainment into BSPP but everywhere else the likelihood of entrainment into BSPP was close to zero. Predicted losses to agricultural diversions were relatively high in some locations but showed no relationship to distance from BSPP. For particles released within Lindsey Slough, median predicted losses to BSPP were several times higher in the dry year (2021; Figure 8-18). There was also some interaction between predicted transport to agricultural diversions and BSPP for particles released into Lindsey Slough, especially at node 326 where transport to one or more agricultural diversions was predicted to occur faster than transport to BSPP, leaving smaller fractions of particles available to be transported to the latter (Figure 8-19).

It is now recognized that in low outflow years, most of the longfin smelt DPS spawns in Suisun Bay and the Sacramento-San Joaquin confluence (Gross *et al.* 2022, p. 187), but in drought years, larval hatching in the CSC can represent circa 10 percent of the total (Gross *et al.* 2022, their Fig. 9). In wetter years, the fraction visually appears to be less than circa 2 percent. These authors did not indicate how much of the CSC hatching was associated with

Barker and Lindsey sloughs in particular. The CDFW Smelt Larva Survey which is used to gage the distribution of hatching sized longfin smelt does not sample in Barker or Lindsey sloughs, so data are not currently available to better refine our understanding of where longfin smelt may spawn in the CSC. Based on this limited information, we conservatively conclude:

- All longfin smelt individuals spawned within Barker and Lindsey Sloughs will be lost to entrainment. Larvae spawned elsewhere in the CSC will have very low vulnerability to BSPP.

- The population level loss to BSPP should be less than 10 percent of hatching larvae in critically dry years, possibly much less, and less than 2 percent in wetter years, possibly much less. The Service believes the localized hydrodynamic effect of BSPP makes it more likely than not to be a very minor source of mortality for larval longfin smelt that would have no discernable effects on the species' population dynamics, which best available information suggests that during early life, are overwhelmingly influenced by how Delta outflow affects the habitat function of the low-salinity zone.

Roaring River Distribution System (RRDS)

The RRDS is one of two water diversion and distribution systems operated by DWR that is used to increase the circulation of water for managed wetlands in Suisun Marsh. It diverts water through a screened intake off of Montezuma Slough near the SMSCG and distributes the water to wetlands south of Montezuma Slough. Under the PA, the RRDS will maintain a maximum approach velocity of 0.2 ft/second at the intake fish screens. During mid-September through mid-October, water diversions into RRDS increase to support a fall flood-up of wetlands to ready them for the arrival of winter waterfowl. During this one-month period, DWR proposes to divert water into RRDS at rates that result in approach velocities up to 0.7 ft/second. The RRDS intakes are screened (3/32-inch opening, or 2.4 mm) and physically exclude fish greater than ~ 26 mm in length from being entrained.

Therefore, operation of RRDS can entrain larvae and small juveniles in the winter and spring. Once longfin smelt grow to lengths greater than 30 mm, mostly in April or May, RRDS can only result in take if individuals are impinged onto the screens. It is not known whether and how often this occurs. Experimental evidence on various fish species suggests that as approach velocities increase, the risk of impingement will as well (e.g., Swanson *et al*. 2005, their Fig. 2; Mussen *et al*. 2015, their Fig. 2; Stocks *et al*. 2024, their Fig. 4).

During December through May when longfin smelt < 26 mm are present, any effects entrainment is expected to be similar between the NAA and PA because there has been no proposed change in the operation of RRDS and it affects a relatively small proportion of the overall population. Beginning in May or June, longfin smelt begin moving seaward so few if any individuals would remain in the vicinity of RRDS. The 0.7 ft/second approach velocity in September and October may result in greater impingement on the screens than the 0.2 ft/second approach velocity. Longfin smelt begin returning to the estuary in the fall as water temperatures cool (Table 10-1). By this time all or very nearly all individuals are more than 26 mm long. Fewer longfin smelt are returning to the estuary in September and October than they once did. This change in migratory timing behavior would have the ancillary benefit of lowering the fraction of longfin smelt that might pass close by the RRDS during the period of higher approach velocity in September-October. Impingement is the more likely take mechanism for these juvenile and adult fish that return in the fall. However, the Service considers higher impingement mortality to be infrequent because the RRDS intakes are positioned in a part of Montezuma Slough where the channel is about 300 to 350 feet wide and longfin smelt would need to be within a few feet of the fish screens to have any vulnerability to variation in approach velocities through the screens. The information that we have available indicates longfin smelt generally avoid in-water structures and would therefore have little tendency to be in close proximity to the RRDS intakes, particularly given the substantial width of the adjacent channel.

<u>Morrow Island Distribution System (MIDS)</u>

The MIDS is the second Suisun Marsh water distribution system. It diverts water off of Goodyear Slough through a set of unscreened intakes and redistributes the water in the westernmost parts of Suisun Marsh. Drainwater is eventually returned to Grizzly Bay. Longfin smelt have been observed to be entrained into MIDS (Enos *et al*. 2007, their Table 4). Under the PA, individual longfin smelt of all free-swimming life stages are expected to be entrained by the three unscreened 48-inch intakes that form the MIDS intake. We do not expect the operation of the MIDS during the summer to affect longfin smelt distribution because the DPS occupies the full estuarine salinity gradient beginning by about its first summer of life (see *Suisun Marsh Salinity Control Gate* section) and would therefore not be in the area influenced by MIDS operations. The Service expects that mortality is likely to occur when individual longfin smelt enter the intakes because we consider it unlikely that longfin smelt would survive on the managed wetlands given their extremely shallow wetted depths.

Delta Cross Channel

Reclamation uses the Delta Cross Channel (DCC) to divert Sacramento River water into the South Delta via the north and south forks of the Mokelumne River (BA *Section 3.7.2*, p. 3-58). The use of these gates has several benefits to the project, but their use can also entrain emigrating salmonids into the South Delta where survival is lower. The BA describes a range of DCC operations in *Sections 3.7.2.1* through *3.7.2.6*. This includes full-time gate closure from February 1 through May 20 each year (BA *Section 3.7.2.4*).

Adult longfin smelt and their progeny have occasionally been collected in the vicinity of the DCC (Merz *et al*. 2013, their Fig. 5), but the Service considers this a transiently used area that supports a small fraction of total spawning. The DCC gates may or may not be open during December and January when many adult longfin smelt are spawning (BA *Section 3.7.2.3*). They will be closed for several months thereafter (BA *Section 3.7.2.4*). Opening and closing the DCC gates may change where these longfin smelt end up, but it is not known whether such relocation has a consequence to survival similar to what has been demonstrated for Chinook salmon smolts. It is likely that larvae hatching along the

Sacramento River upstream of the DCC will more or less be passively distributed downstream. Most of this larval transport is anticipated to occur during December through February. If the DCC gates are open while longfin smelt larvae are moving past them, they will have a higher likelihood of being transported into the Mokelumne River forks and then into the San Joaquin River than when the gates are closed (Kimmerer and Nobriga 2008, p. 15). The Service has no information to suggest that of itself this redistribution will result in negative effects.

The PA includes a large set of OMR flow rules designed to minimize the entrainment of fish including longfin smelt larvae (BA *Section 3.7.4* and associated subsections). Based on this, the Service expects take related to operation of the DCC gates to be possible in some years during December and January. However, this is anticipated to be of no population consequence given longfin smelt's infrequent use of the area influenced by the DCC gates and the Service's lack of information suggesting an effect on longfin smelt resulting from operation of the DCC other than the potential for transport of a few larvae into the South Delta.

South Delta Fish Facilities and Clifton Court Forebay activities

The Service considers all longfin smelt to have been entrained and therefore 'lost' to the population once they enter Old or Middle rivers. The PA includes OMR actions designed to limit entrainment. As such, any effects of operation of the Tracy Fish Collection Facility (BA *Sections 3.7.3*, *3.7.7* and *3.7.7.1*), Skinner Fish Protection Facility (BA *Sections 3.7.8*, *3.7.8.1*, and *3.7.8.2*), the Clifton Court Aquatic Weed Management (BA *Section 3.7.14*), Agricultural Barriers (BA *Section 3.7.12*), Sisk Dam (BA *Section 3.7.15*), and Contra Costa Water District Rock Slough Intake operations have already been evaluated above and are not evaluated further. The Rock Slough intake is north of the Banks and Jones pumping plants and their affiliated fish facilities, but the Rock Slough diversion has a positive barrier fish screen and a maximum diversion rate of 350 cfs so it does not meaningfully affect our analysis of longfin smelt entrainment effects in the South Delta.

Water Transfers

Reclamation and DWR propose to operate the CVP and SWP to facilitate transfers by providing water in streams for delivery to alternative diversion points, conveying water across the Delta for export, or storing water for delivery at a future time. The PA includes transfers of water, up to contract totals, between CVP contractors within counties, watersheds, or other areas of origin (e.g., Accelerated Water Transfers). Transfers not meeting these requirements, including Out of Basin transfers (e.g., Long Term Water Transfer Program (North to South-of-Delta Transfers, Long Term San Joaquin River Exchange Contractor Transfers, "Warren Act Transfers"), follow a separate process and are not included in this consultation.

The actions taken by contractors to make water available for transfers (i.e., reducing consumptive use by crop idling, contractor reservoir releases or groundwater substitution) are addressed under separate consultation as described in the Environmental Baseline; therefore, effects from making the transfer water available are not addressed in this consultation as effects of the PA. However, the specific timing and operations associated with the movement of the water to be transferred is a component of the LTO PA and is covered by this consultation.

Reclamation and DWR will provide a transfer window across the Delta from July 1 through November 30. When pumping capacity is needed for CVP or SWP water, Reclamation and DWR may restrict transfers. Maximum transfers are shown in Table 14 in Section 3.7.12 of Appendix 2 - Proposed Action.

Water transfers would be subject to all measures applicable for the Delta, including Seasonal Operations (Section 3.7.1) and Old and Middle River Flow Management (Section 3.7.4 of the BA). Therefore, we do not anticipate additional effects to the longfin smelt DPS resulting from water transfers.

Drought Toolkit

Droughts and low flow years more generally have contributed to the long-term decline of the longfin smelt DPS (Service 2024, p. 28). Reclamation proposed the development of a Drought Toolkit as a way to optimize the management of multiple objectives during droughts (BA *Section 3.12*). The BA outlines a process for development, coordination, and implementation of Drought Toolkit actions. However, no description of these actions and if or how these actions would be designed and implemented were provided in time to incorporate into the effects analysis of this BiOp. Therefore, the Service is addressing the actions in the Drought Toolkit under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp.

Drought or dry year actions that were mentioned in the BA as possible elements of the Drought Toolkit include: rebalancing between other CVP reservoirs with moderate impacts to other parts of the system, transfer timing modifications, situation-specific adjustments to Delta water quality standards under D-1641 to address developing drought conditions and other actions, designing habitat projects with drought refugia and resilience in mind, and investments in other habitats for salmon spawning. Planning and implementation of actions will depend on various factors that are not known at this time, such as locations and extent of particular actions and where or if they may overlap with listed species habitat.

The framework proposed for development of drought or dry year actions involves the following collaborative process. The DRY team will meet at least monthly starting in October and will assess if drought conditions are developing or are present. If warranted, this team will review actions in the Drought Toolkit and determine if it would be appropriate to pursue any of them and evaluate the effectiveness of those actions.

As described in Section 3.13 Governance of the BA, the WOMT and SHOT will coordinate with each other as needed on operational issues and decisions that have implications for both of their respective purviews, including but not limited to Drought Toolkit implementation.

CVP/SWP operation for proposed actions from the Drought Toolkit like drought barriers will require modeling and analysis. Operation with drought barrier(s) in place, in addition to drought conditions themselves, are likely to alter hydrodynamics within the Delta, exacerbate poor water quality conditions in the west Delta further limiting habitat availability, improve water quality conditions in the central Delta, and increase harmful algal blooms and aquatic invasive vegetation. These hydrodynamic changes are likely to affect the longfin smelt DPS depending on the timing of when these barriers would be in place. In the summer and fall, longfin smelt should be further west and unaffected by the hydrodynamic changes. If the barriers are in place when larvae and post-larvae are likely to be present (December through May), further analysis (which may include particle tracking modeling and assessment of outflows) will be necessary to determine the likelihood of effects to this life stage.

As described in the *Consultation Approach* section of this BiOp, a framework programmatic approach is used for proposed actions that will require subsequent consultations to address effects to listed species and critical habitat, and no incidental take is likely to occur until those subsequent consultations are completed. Reclamation proposes to request initiation of section 7 consultation for any actions proposed to be implemented from the Drought Toolkit that may affect species or critical habitat.

Reclamation and DWR will coordinate with the Service on design of Drought Toolkit actions via the DRY team. Detailed information regarding the location, extent, overlap with listed species habitat and designated critical habitat, timeframe, and other relevant information will be developed for each action. Reclamation will prepare a Biological Assessment for each Drought Toolkit action that may affect listed species or critical habitat and provide to the Service with adequate time to complete the necessary subsequent consultations.

Monitoring

Monitoring is used to help us understand status and long-term trends of the estuary ecosystem and the effects of operations of the CVP and SWP, including when to implement protective measures to avoid and minimize the effects of the Proposed Action by informing specific real-time actions. Ongoing monitoring is addressed under separate section 7 consultations and section 10(a)(1)(A) permits that are described in the Environmental Baseline; therefore, adverse effects of ongoing monitoring are not addressed in this BiOp as effects of the PA.

Reclamation and DWR propose a framework programmatic consultation approach to address future changes to monitoring associated with the PA. Subsequent changes to existing monitoring programs would be coordinated amongst the involved agencies and would require subsequent consultation. Changes outside the scope and effects in the existing consultations and permits are not authorized to commence until subsequent consultation is completed. The framework programmatic consultation approach includes several principles which would be incorporated into any future changes to monitoring programs addressed in a subsequent consultation (BA Section 3.10). These principles include assurances that effects from monitoring to listed species are minimized, and that the information is synthesized and is coordinated with the proposed Adaptive Management Program to inform operational decisions and potential future modifications to operational measures. A multi-agency structure would be developed to make decisions about how monitoring would be implemented, further assuring that monitoring deployment is designed to meet all objectives.

Spring Delta Outflow/Healthy River and Landscapes Program **(March through May)**

It has been recognized for more than 40 years that the abundance of longfin smelt increases as a function of wet season Delta outflow or its corollary, X2 (Stevens and Miller 1983, their Table 8; Jassby *et al*. 1995, their Fig. 5; Thomson *et al*. 2010, their Fig. 6). By extension this means that early life survival tends to increase with increasing Delta outflow (Service 2024, p. 28). The timing of when the wet season flows are most important was recently suggested to be after March (Kimmerer and Gross 2022, p. 2741). However, *Appendix J Spring Delta Outflow, Attachment J. Longfin Smelt Outflow*, which we incorporate here in full by reference, provides a regression model framework that is a partial counterpoint to Kimmerer and Gross' conclusion (Figure 10-6). Reclamation's analysis shows that although outflow averaged March-May seems to outperform a longer December-May average when predicting relative abundance of longfin smelt, upon further examination through leave-one-out techniques, the latter ends up having a larger contribution to predictive power. We interpret this as evidence that the timing of the effect of outflow on the longfin smelt DPS survival may retain some important uncertainty. The regression model incorporates both averaging periods and reflects the effect of climate-scale outflow variation on predictions of the longfin smelt DPS abundance albeit with high prediction uncertainty (Figures 10-10 and 10-11). The model was fit with two statistical 'change-points' that break the data into three regimes: 1) the period before the overbite clam (*Potamocorbula amurensis*) had invaded the estuary and permanently rearranged the pelagic food web in the low-salinity zone, 2) the period during which the overbite clam was doing that, and 3) a subsequent 'pelagic organism decline' or "POD" period during which trawl catches of fish including the longfin smelt DPS abruptly declined and have remained low.

Figure 10-10: Time series of the California Department of Fish and Wildlife's Fall Midwater Trawl index on a log-10 scale for *the longfin smelt DPS for 1967-2022*

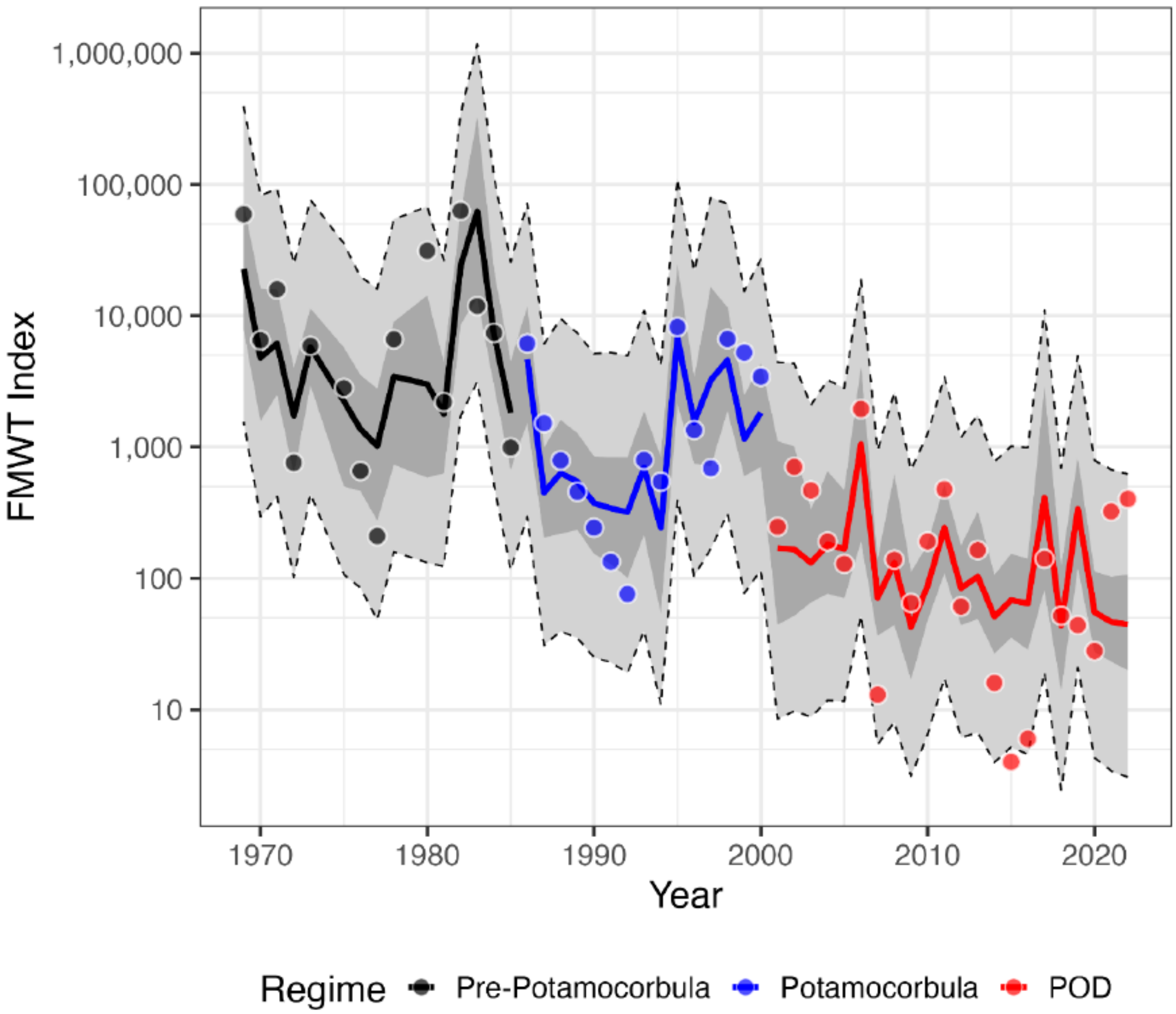
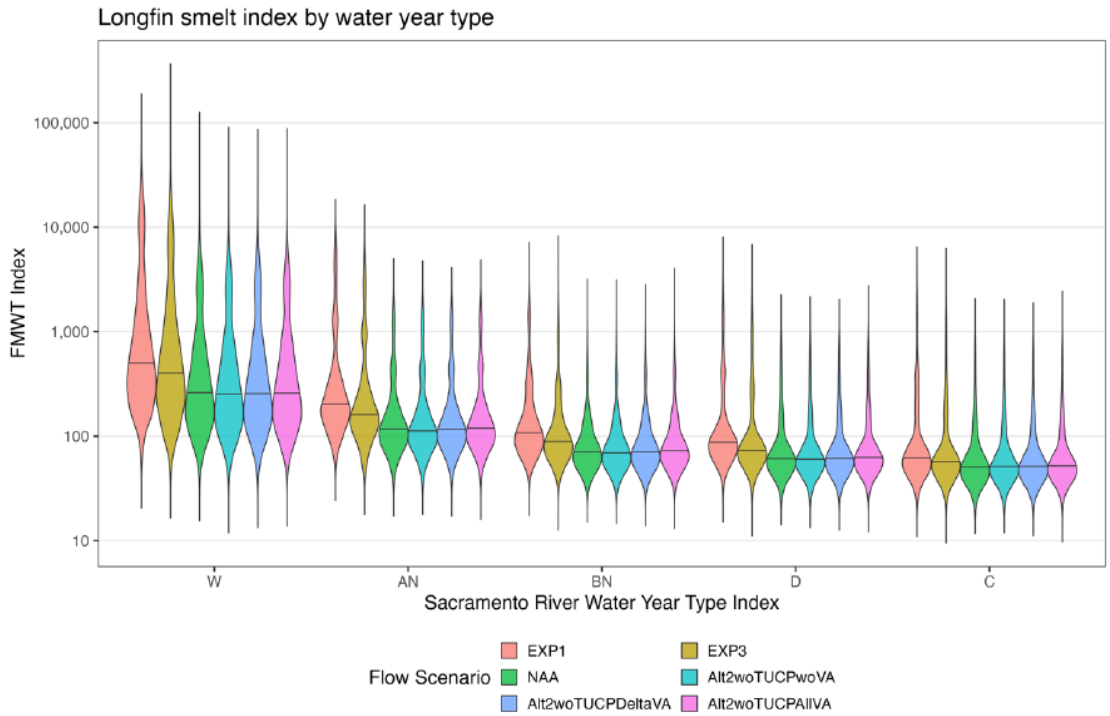
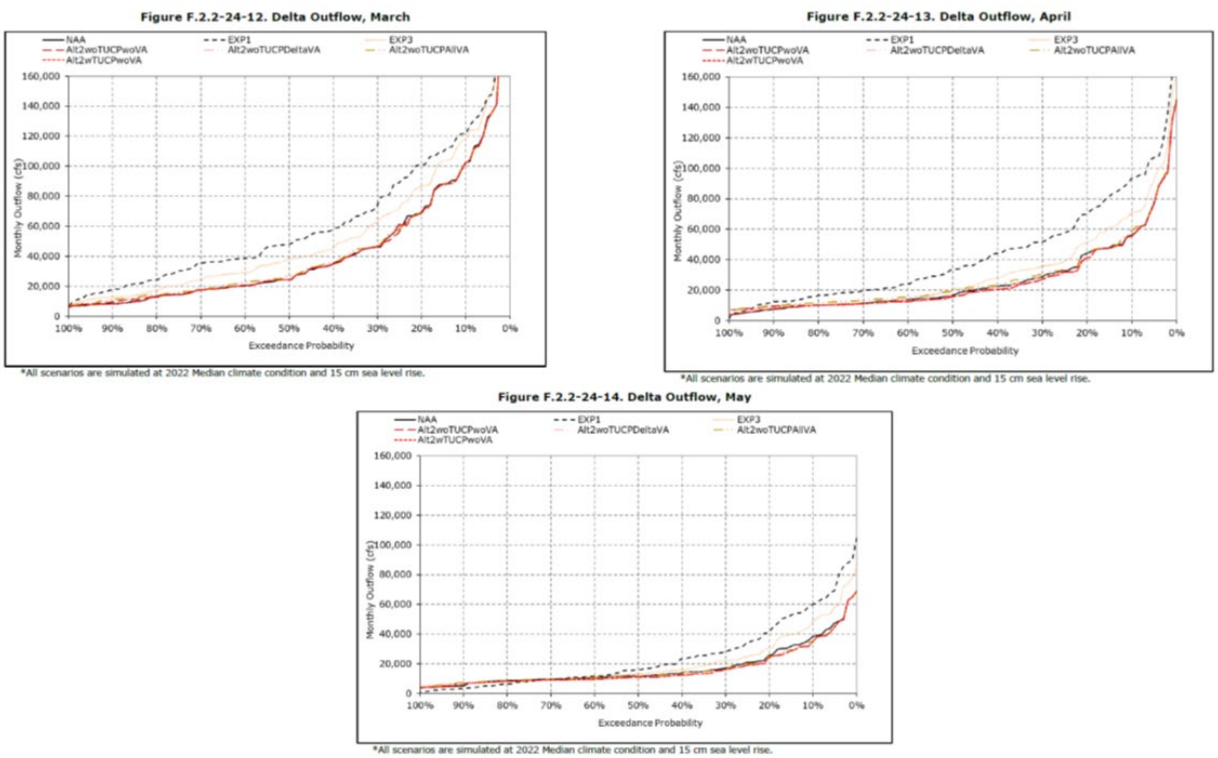


Figure 10-11: Violin plots summarizing 100 years of predicted longfin smelt Fall Midwater Trawl abundance indices as a function of water year type



As described in the "Spring Delta Outflow/Healthy Rivers and Landscapes" subsection under the *Consultation Approach* section above, this BiOp addresses the HRL pre-adoption period as a standard consultation and the HRL post-adoption period as a framework programmatic consultation. If the HRL program is fully implemented, the Delta could receive an average of 150 TAF, 825 TAF, 751 TAF, 826 TAF, and 155 TAF of additional outflow in Wet, Above-Normal, Below-Normal, Dry, and Critical water year types, respectively (BA *Table 3-12*). In addition, DWR has accounted for an SWP portion of the HRL program focused on Above-Normal, Below-Normal, and Dry water year types (ITP application Table 16) and included an HRL pre-adoption implementation plan that can be implemented in one of two ways to generate conditions in the Delta similar to what was in CDFW's 2020 ITP condition of approval 8.17 (*ITP application Section 3.3.3.2*). The HRL pre-adoption actions describe plans to increase Delta outflow via temporary reduction of exports from the South Delta. At face value, whether the HRL program is implemented or not, CalSim 3 modeling suggests the statistical distributions of Delta outflow in the spring months would remain very similar to the NAA (Figure 10-12) and Reclamation concluded that given uncertainty in longfin smelt abundance predictions, the modeled variations of Alternative 2 do not produce distinguishable results (BA *Section 10.2.1.2* and its associated Figs. 8 and 9).

Figure 10-12: Exceedance plots of CalSim3 predictions of Delta outflow for the months of March, April, and May



These predictions of the longfin smelt DPS relative abundance come from the model shown in Figure 10-10, which includes Delta outflow as a continuous predictor of Fall Midwater Trawl abundance indices. Thus, *a priori*, it is intuitively obvious that inputting a higher outflow alternative will generate point estimates that predict higher abundance of the longfin smelt DPS. Even in the Bayesian modeling framework shown in Figures 10-10 and 10-11, the model's average posterior prediction is higher when outflow is higher. This can be visually hidden inside of the substantial prediction uncertainty (Figure 10-11), but there are different ways to think about probabilistic model outcomes that can help the Service evaluate potential effects of the PA variants.

Reclamation provided 100 years of predicted longfin smelt relative abundance as simulated Fall Midwater Trawl (FMWT) indices (BA *Table 3* in *Appendix J Spring Delta Outflow, Attachment J. Longfin Smelt Outflow*). The table includes results for the NAA baseline and all four modeled alternatives of the PA ("Alt2s"). The first thing to note is the approach to predicting effects described in Reclamation's appendix attachment removed the substantial decline in the FMWT indices that was observed between 1967 and 2022 by using only the data in the final change point in the predictions (the data shown in red in Figure 10-10). This resulted in a hyper-stable model that predicted FMWT indices in simulated 2022 that were about the same as where they started in simulated 1922. This 100-year stability clearly differs from the empirical information even though the model fits those data well (Figure 10-10). The hyper-stability comes in part from the model's assumed distribution for longfin smelt relative abundance; it uses a negative binomial which can only predict positive non-zero numbers without the use of a 'quasi-extinction' index level similar to Tobias *et al*. (2023, their Section 2.6). The other likely reason is that the analysis only models the influence of Delta outflow on population dynamics and the long-term decline has been driven by a combination of long-term decline in Delta outflow, changes to estuarine food webs, and rising water temperature (Service 2022, p. 28).

In addition to estimated FMWT indices for each scenario, Reclamation provided the predicted percent change between each set of "Alt2" results relative to the NAA (BA *Table 3* of *Appendix J Spring Delta Outflow, Attachment J. Longfin Smelt Outflow*). In any given year, the predicted percent difference was usually small. For instance, the 100-year average difference across all four Alternative 2 scenarios combined was only -0.18 percent (calculated by Service staff). This is so close to zero that like the visual summaries of results presented in Figure 10-11, it does not seem to represent a meaningful change from the NAA baseline. Given the model's unrealistic hyper-stability however, we were interested in exploring how frequently each of the Alternative 2 predictions were higher or lower than the NAA. We reasoned this frequency analysis might provide a better indication of whether these potential operational alternatives produce results that meaningfully differ from the NAA or from one another.

The Service transcribed the annual percent change data in BA Table 3 of *Appendix J Spring Delta Outflow, Attachment J. Longfin Smelt Outflow* then calculated the number of times each alternative had a FMWT index prediction higher than the NAA prediction for the same year. The result is summarized in Table 10-2.

Table 10-2: Summary of BA Table 3 of Appendix J Spring Delta Outflow

Scenario	Description	Number of predictions higher than NAA
Alt2v1a	PA with no TUCPs and no HRL actions	24
Alt2v1b	PA including TUCPs and no HRL actions	34
Alt2v2	PA with no TUCP and the “Delta” HRL that increases outflow using export reductions	65
Alt2v3	PA with no TUCP and the full HRL	83

A noisy but accurate model of a process will sometimes generate predictions that are too high and sometimes generate predictions that are too low. If two hypothetical scenarios ‘a’ and ‘b’ were being compared with such a noisy model and the predicted results were approximately equivalent, then for a 100-year time series, the null expectation would be that about 50 of the scenario ‘a’ predictions would be higher than scenario ‘b’ and the other 50 would be lower. The data in Table 10-2 deviate from that 50:50 expectation so we were curious to determine how likely deviations of this size are when the sample size is so high (n=100 years).

We used the R environment to evaluate the probability of randomly drawing the results in Table 10-2. This can be conceptualized as tossing a coin 100 times and if the "Alt2" prediction is higher than the NAA, that is 'heads'; if it is lower, it is 'tails'. If we think of 'heads' = 1 and 'tails' = 0, this experiment is coded as [rbinom(1, 100, 0.5)], which outputs the number of heads (i.e., 1) from 100 'coin flips' with the probability of getting heads equal to 0.5. We repeated this experiment one hundred thousand times and found that the number of times the Alternative 2 results exceeded the NAA was unlikely to be random (Figure 10-13). Thus, it would appear that each Alternative 2 model run is predicting a change in longfin smelt FMWT index relative to the NAA; the model runs including some form of HRL are higher than the NAA more often than expected and the model runs lacking some form of HRL are lower than the NAA more often than expected. When the predicted percent changes from each alternative are summed over the 100-year horizon, the alternative versions of the PA diverge over time showing the direction of incremental change that the model predicts would result from the different flow regimes (Figure 10-14). When the results are plotted this way, the full HRL (Alt2v3) is predicted to incrementally increase the abundance of the longfin smelt DPS.

Figure 10-13: Histogram summarizing the expected number of heads in 100 coin tosses.

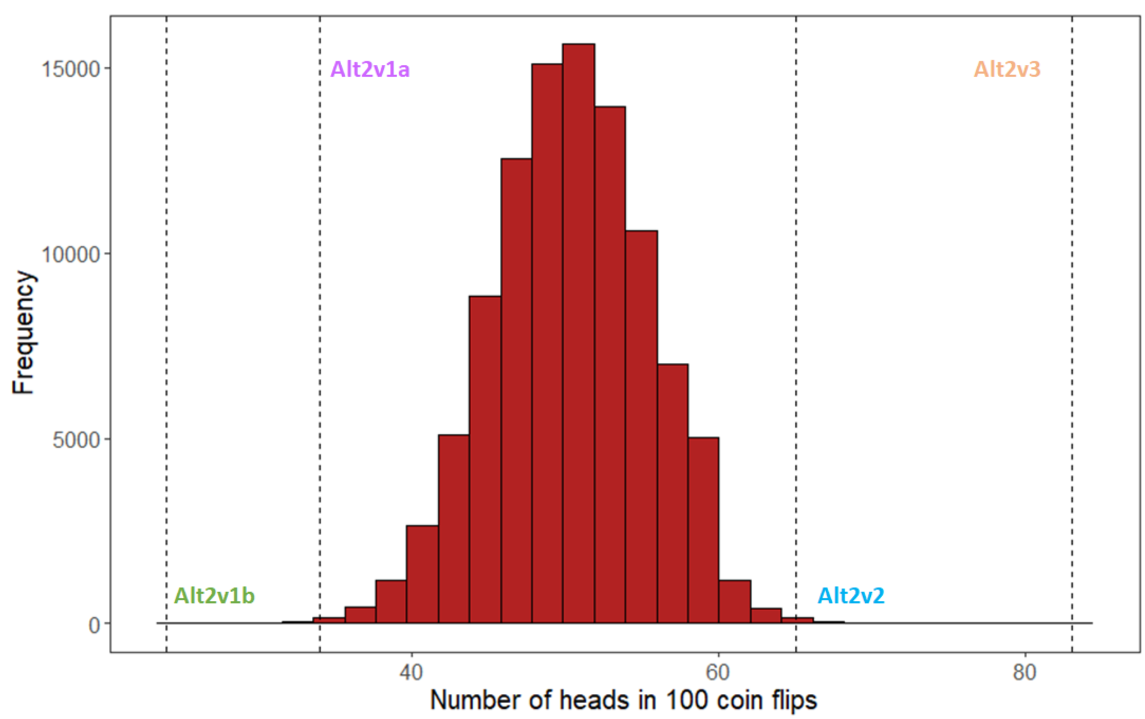
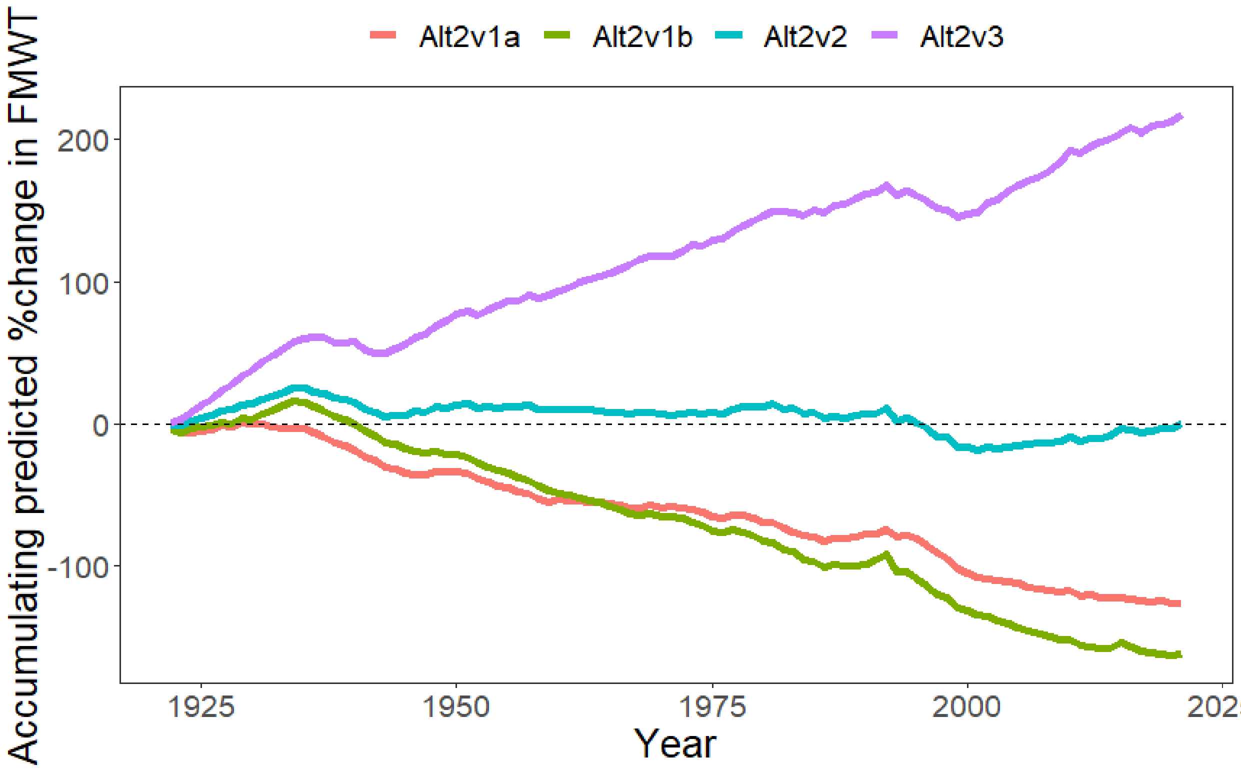


Figure 10-14: Accumulating sums of the predicted annual percent change in the Fall Midwater Trawl abundance index for the longfin smelt DPS.



Based on our analysis of the PA and its predicted effects we conclude:

- the additional Spring Delta Outflow proposed in the full HRL program would likely have incremental beneficial effects on the longfin smelt DPS as compared to the NAA.

If the SWRCB does not approve the HRL or the parties do not execute the agreements in order to implement the HRL, reinitiation of this consultation may be necessary.

Delta Smelt Summer-Fall Habitat Action

The Delta Smelt Summer-Fall Habitat element of the PA is intended to help mitigate low survival of delta smelt during the summer and fall. It includes operation of the SMSCG during summer and fall (BA Section 3.7.6.2; [Table 10-3]) and a Fall X2 action (BA Section 3.7.6.1) but we also have to consider whether it may have effects on the longfin smelt DPS.

The Fall X2 action is a 'pulse flow' in September of Wet and Above-Normal water years that carries over into October, which is officially the subsequent water year. As proposed, the pulse of freshwater would maintain a 30-day average X2 at 80 km in both months, unless modified through adaptive management. More detail about each element of the Summer-Fall Habitat Action is available in the delta smelt effects analysis of this element of the PA.

Longfin smelt use the estuary very differently than delta smelt. A fundamental difference is the seasonality of the longfin smelt DPS's distribution in the estuary. By July, when the SMSCG would begin to be operated, the distribution of the longfin smelt DPS is not constrained by an upper salinity bound. Thus, any individual longfin smelt that wanted to rear in the marsh could do so with or without this action. The age-1 and older longfin smelt reach seasonal maxima in Suisun Bay and the Delta during the first part of their spawning season in December and January and seasonal minima throughout the estuary somewhere around July or August (Figure 10-15). Note that the increase in predicted capture probability of the age-0 fish from March through December has to do with recruitment to the Bay Study nets, not with spatial distribution, which has been shown using other information to move increasingly seaward beginning in May or June (see below). Larval and young juvenile longfin smelt are commonly collected in Suisun Bay and the Delta during winter and spring in programs like the 20-mm Survey that use nets with smaller mesh sizes than the Bay Study, but patterns across multiple IEP surveys also show the substantial decline in abundance that occurs between May and July that reflects a combination of mortality and seaward movement (Figure 10-16).

Table 10-3: Summer-Fall Habitat Action Requirements

Water Year Type	Gate operation	Salinity target (PSU)
Wet	None	None
Above-Normal	60 days	4
Below-Normal	60 days	4
Dry	*Following a Wet or Above-Normal year*: 60 days *Following a Below-Normal year*: 30 days, and as required to meet D-1641 salinity standards in Suisun Marsh	4 6
Critical	Only as needed to meet D-1641 salinity standards in Suisun Marsh	None

Figure 10-15: Predicted Probability of Longfin Smelt Capture

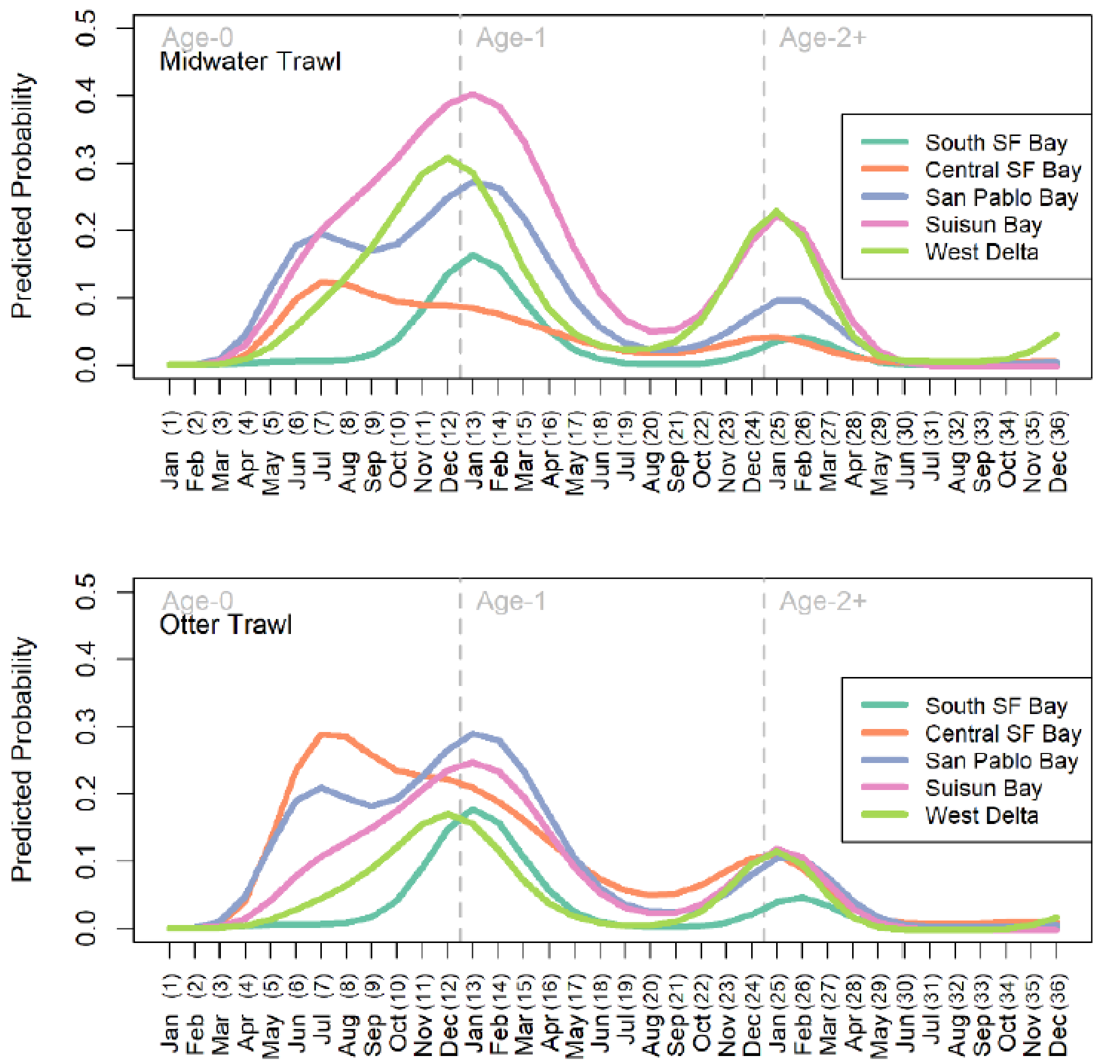
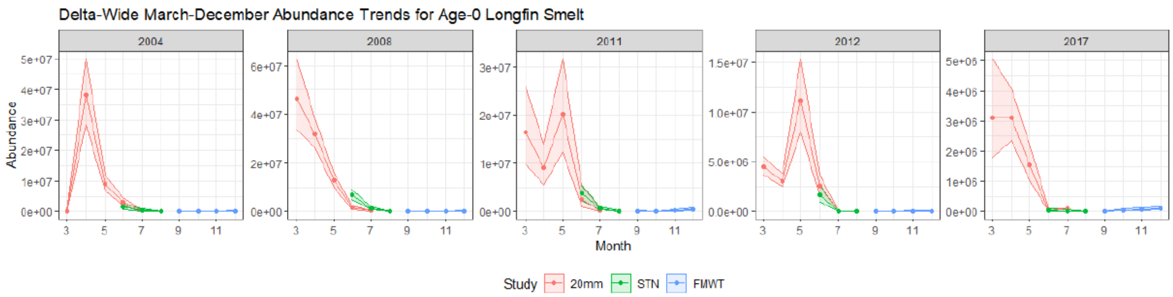


Figure 10-16: Delta Wide March-December Abundance Trends



When longfin smelt begin returning to the estuary in the fall, distribution is broad but is influenced by X2 (CDFW 2020, their Fig. 2). However, there is no information available to indicate that the location of X2 affects survival of fish by this stage in their life beyond potentially affecting the risk of entrainment. The effects of entrainment of the longfin smelt DPS were covered in *OMR Management and Seasonal Operations*.

Based on our analysis of the PA and its predicted effects we conclude:

- The Delta Smelt Summer-Fall Habitat Action will not have discernable effects on the longfin smelt DPS.

<u>Tidal Habitat Restoration</u>

Reclamation and DWR propose to finish restoring and protecting the remainder of the 8,000 acres and an additional 396.3 acres of intertidal and associated subtidal habitat restoration in the Delta and Suisun Marsh by 2026. There is high scientific certainty that restoration of more than 8,000 acres of aquatic habitat will increase the net aquatic primary production in the Delta and Suisun Marsh/Bay (Cloern *et al*. 2021, their Table 3). The location of all eleven restoration sites within the North Delta Arc helps to maximize the likelihood that longfin smelt will encounter them; however, the more westerly sites can be expected to be used more than the inland locations (Kimmerer and Gross 2022, their Fig. 3).

The tidal habitat restoration locations were largely chosen with delta smelt in mind; however, staging and spawning adult longfin smelt have been routinely reported in surveys of Suisun Marsh (Rosenfield and Baxter 2007, their Fig. 7c) and longfin smelt larvae occur in marsh habitats at densities comparable to those collected in offshore trawls (Grimaldo *et al*. 2017, p. 1777). Longfin smelt have been collected in small numbers from shallow marsh habitats similar to the proposed restoration sites (Gewant and Bollens 2012, their Table 2; Williamshen *et al*. 2021, their Table S3).

We expect the utility of each restored site to vary by location and within and among years as other habitats used by longfin smelt currently do; variation in Delta outflow is reflected in the population distribution and predictions of local habitat suitability (Grimaldo *et al*. 2020, their Fig. 6; Service 2022, their Fig. 2.7). Potential beneficial effects of habitat restoration include added areas with elevated prey abundance or diversified foraging opportunity in or adjacent to restored sites (Grimaldo *et al*. 2017, pp. 1781-1782). Restoration of wetlands may enhance food supplies for pelagic fishes that enter wetlands to feed (Young *et al.* 2021 from Yelton *et al.*, 2022, p. 1743). However, there is little evidence of persistent subsidies of zooplankton from tidal wetlands to open water (Dean *et al.* 2005; Mazumder *et al.* 2009; Kimmerer *et al.* 2018; Yelton *et al.*, 2022, p. 1743). Food subsidy movement between wetlands and adjacent waters depend on the detailed interactions between site- and season-specific hydrodynamics and copepod behavior. (Yelton *et al.*, 2022, p. 1743).

Potential negative effects include the perception or realization of elevated predation risk that limits how often or how effectively longfin smelt can access new foraging opportunities (Service 2024b Section 3.1.5). The high potential for substantial encroachment by invasive plants is noted. As stated by Christman *et al*. (2023, p. 9):

> SAV [submerged aquatic vegetation] and FAV [floating aquatic vegetation] represent a significant management challenge for restoration of Delta habitats to benefit special-status species. Generally speaking, restoration projects provide new niche space for species and lead to an increase in non-

> native species cover. For example, when the Prospect Island east levee was breached, *Ludwigia* spp. spread rapidly and covered hundreds of acres in the restoration site [author citations omitted]. SAV has already colonized tidal marsh restoration sites throughout the Delta in varying severity (Barker Slough, Little Holland Tract, Liberty Island Conservation Bank, Decker Island, Blacklock Marsh; [author citations omitted]).

Restoration sites that are heavily encroached upon by invasive vegetation may have lower utility for longfin smelt, which are generally associated with open-water habitats like channels and adjacent shoals (Hobbs *et al*. 2006 p. 912; Rosenfield and Baxter 2007, p. 1586; Young *et al*. 2024b, their Figs. 4 and 7).

Primary production in tidal wetlands within the Bay Delta estuary have been shown to support high zooplankton growth (Mueller-Solger *et al*. 2002). Tidal restoration projects in the estuary have generally created fish feeding benefits very quickly (Cohen and Bollens 2008; Howe and Simenstad 2011). Following Herbold *et al*. (2014), the restoration projects are sited and designed to locally increase food web production in locations longfin smelt should be able to access. These proposed restoration actions are therefore expected to enhance the food web on which the longfin smelt DPS depends. Some longfin smelt are expected to forage within restored sites, but most individuals will likely remain in offshore locations. Restoration will be designed to increase primary and secondary production in the Delta and Suisun Marsh by increasing the quality and quantity of tidal wetlands on the landscape. Tidal exchange of water between wetlands and surrounding channels is expected to distribute primary and secondary production from the wetlands over short distances to adjacent pelagic edge habitats where longfin smelt have greater access to it. Tidal exchange will be optimized through the intertidal habitat restoration design by incorporating extensive tidal channels supported by appropriately sized vegetative marsh plains.

As demonstrated in Table 16 of Section 3.7.9 of the BA, most of the acreage has been constructed or is under construction. The effects of construction of all of these projects have been addressed under separate consultations with the Army Corps of Engineers. One of the slated projects (Chipps Island) has not yet been permitted, but consultation has been initiated by the Corps on this project. The BA for Chipps Island contains a framework, including conservation measures to minimize the effects of construction of the project, that will inform this consultation. Based on consultations on previous tidal habitat restoration projects and the framework and conservation measures proposed in the Chipps Island BA, we expect that the following types of activities are likely to affect the longfin smelt DPS, but this list does not include all possible effect mechanisms: vegetation removal for site preparation, access routes, construction staging, earthwork, breaching of berms or levees, new berm construction, tidal network creation, pond creation, in-water construction activities, dredging, water quality and biological monitoring, and long-term management activities. The nature and magnitude of adverse effects of tidal habitat restoration will vary depending on project design, site location, and construction timing, magnitude, and duration.

Reclamation and DWR commit to ensuring that monitoring, operation, maintenance, and permanent protection occur on these restored lands (see *Appendix A, Attachment 2: Tidal Habitat Restoration Administrative Process and Documentation Requirements* of the BA). Monitoring, management, and permanent protection of these sites (through conservation easements or other perpetual mechanisms) are important to ensure they continue to function for the benefit of the target species. The Fish Restoration Program (FRP) was established in 2012 by agreement between DWR and CDFW to implement the tidal habitat restoration requirements which began in 2008 and are carried forward in this consultation. The FRP has been monitoring the restored sites continuously since 2012, primarily focused on phyto- and zooplankton since the primary role of the restoration is to provide food web support for delta smelt. These sites are and will continue to be monitored for effectiveness of the restoration actions and will inform future actions under the proposed Adaptive Management Program considered and undertaken for the benefit of the longfin smelt DPS.

Based on our analysis of the PA and its predicted effects we conclude:

- The balance of beneficial effects and negative effects of restoration on the longfin smelt DPS will vary among restored sites;

- The balance of beneficial effects and negative effects of restoration on the longfin smelt DPS will vary over time (seasonally and inter-annually); and

- The proposed Adaptive Management Program (BA Section 3.14) can be used to inform efforts to maximize benefits and minimize negative effects based on on-going effectiveness monitoring.

Sites Reservoir and Delta Conveyance Projects

Reclamation (for Sites Reservoir) and the U.S. Army Corps of Engineers (for DCP) propose to initiate separate section 7 consultations for the non-operational construction and maintenance components of these projects. Effects from construction and maintenance will be addressed in those separate consultations, but for context, there will be no effects to the longfin smelt DPS that would be caused by the construction of Sites Reservoir because its proposed location is well to the north of this species' distribution limits. The Service would anticipate some effects to these fish from construction of the DCP, particularly the in-water construction activities along the Sacramento River. The proposed location of the DCP intakes is beyond the typical northern limit for longfin smelt (Merz *et al*. 2013, their Fig. 5), though we acknowledge that at least one individual was reported (but not confirmed) from the Sacramento River up to the town of Colusa (Merz *et al*. 2013, their Fig. 2).

Construction of the DCP intakes is likely to affect individuals from pile-driving noise, elevated predation from in-water disturbance or artificial lighting, trapping behind coffer dams, collection associated with fish salvage operations behind coffer dams or other fish sampling in the vicinity associated with construction-related monitoring, accidental chemical spills, etc. In general, open-water fishes are very capable of avoiding being crushed by falling objects or construction equipment in the water so long as they have space to move around in. The pressure waves and water displacement caused by these kinds of activities are readily detected by shoaling fish, so the Service considers effects from that kind of activity to be unlikely unless the fish are already in a confined space due to other construction activities.

A framework programmatic approach was proposed to address the effects of operations of the Sites Reservoir and DCP. The process for this type of consultation is described in the *Consultation Approach* section of this BiOp. Some project elements and their effects on listed species or critical habitat are likely to change as the proposed action for these new infrastructure projects is developed. As described in Section 3.15 of the BA, future consultations will address the near-field and far-field effects of operations of both Sites Reservoir and new water conveyance facilities in the North Delta with sufficient information to support the site-specific analyses of these projects.

The fundamental role of these projects is to increase the climate resilience of California's water supply and delivery systems by increasing the operational flexibility of the CVP and SWP (BA *Section 3.15.5* and Tables 3-16 and 3-17). The Sites Reservoir would be located in currently unincorporated areas of Glenn and Colusa counties west of the community of Maxwell (BA *Section 3.15.3*). The planned reservoir could store up to 1.5 MAF of water. It will be filled opportunistically at variable rates with a maximum rate of about 4,200 cfs. Water to fill Sites Reservoir will be diverted off the Sacramento River at two existing facilities, one at Red Bluff and the other at Hamilton City. Water released from the reservoir could be released into the Yolo Bypass or the Sacramento River using existing canals, or into the Sacramento River via a new proposed canal near the town of Dunnigan. Currently, Sites Reservoir has 22 planning partners that would receive water supplies from the reservoir. Reclamation is one of them as is the California Water Commission. The California Water Commission is a nine-member entity appointed by the Governor and confirmed by the State Senate to advise DWR and approve any rules and regulations promulgated by DWR (https://water.ca.gov/cwchome).

The DCP would involve a new water diversion facility on the Sacramento River near the town of Hood (BA *Section 3.15.7.2*). A maximum of 6,000 cfs of diverted water would be routed via an underground tunnel to the existing SWP facilities in the South Delta where it could subsequently be delivered to SWP contractors. The number of diversions and tunnels is lower than what was proposed in the California WaterFix (Service 2016). As such, the maximum diversion rate is also lower and the proposed positive barrier fish screen surface areas are much smaller. It is reasonable to expect that there will be some high flow conditions under which both projects could be simultaneously operating at maximum capacity to collectively divert about 10,000 cfs off the Sacramento River.

How these projects will result in changes to flow into and through the Delta, and effects to the longfin smelt DPS that would result from those changes will be addressed in subsequent consultation and through future modeling of both projects combined with LTO.

Guiding principles and conservation measures

Reclamation and DWR propose a suite of guiding principles to avoid, minimize and offset adverse effects of Sites Reservoir and Delta Conveyance to listed species and critical habitat. As described in Section 3.15.8 of the BA, these principles may be adjusted or refined in the future. Reclamation and DWR propose principles for different regions of the system, including Upper Sacramento River (Sites only), Sacramento River from Red Bluff Pumping Plant to Knights Landing (Sites Only), and Below Knights Landing and in the Delta.

Both of these new proposed infrastructure projects will have adaptive management programs that will integrate with the LTO Adaptive Management Program as described in Section 3.14 of the BA. The DCP adaptive management and monitoring program would be used to evaluate and consider changes in operational criteria, if necessary, based on information gained before and after the new facilities become operational. This program would be used to consider and address scientific uncertainty and clarify policy choices regarding the Delta ecosystem and potential effects of the project. In addition, an adaptive management and monitoring plan would be prepared for each mitigation site to help ensure habitat creation goals are met. (Section 3.18, DCP Public Draft EIR). For Sites, criteria may be refined in actual project operations through adaptive management and in coordination with the fisheries agencies.

Reclamation and DWR propose general adaptive management principles (Section 3.15.9 of the BA). These principles generally describe monitoring objectives, studies to inform operational modifications to minimize effects, integration with the LTO Adaptive Management Program, and a commitment to applying adaptive management concepts to mitigation plan design. Specific adaptive management studies were not proposed in this consultation; therefore, none are analyzed.

Section 3.15.8.4 of the BA describes the following guiding principle: "Cooperate with the fisheries resource agencies to monitor effects of diversions to the Sites Reservoir and DCP on the location of X2 and Delta outflow and, as appropriate, identify opportunities to offset adverse effects to critical habitat through appropriate mitigation measures or adaptive management actions." This commitment is important to minimize the possibility of increased diversions upstream of the Delta negatively affecting the longfin smelt DPS by reducing habitat quality and quantity further into the estuary, particularly the low-salinity zone in the spring and summer. For the longfin smelt DPS, mechanisms that result from higher freshwater flow reaching the brackish estuary affect early life stage survival (Service 2022, pp. 31-33).

Guiding principles of operational criteria in the Delta are outlined in Section 3.15.8.3 of the BA. These principles include the commitment to monitor and mitigate the effects of water diversions of Delta aquatic species, including the longfin smelt DPS. This includes further habitat restoration to mitigate the effects of the projects. Specific criteria, such as amount, location, or restoration design is not yet developed, but will be coordinated with the Service, NMFS, and CDFW once more information is known about the nature and extent of these effects. Further coordination on the amount of restoration necessary to minimize or offset the effects of these projects on the longfin smelt DPS will be incorporated into the analyses in the subsequent consultations. Specific conservation measures, including compensatory mitigation, have not yet been developed for both projects. Reclamation and

DWR propose to develop these measures prior to operations implementation; therefore, these measures will inform the subsequent consultations for both of these projects.

Quantitative Analysis

There is preliminary quantitative modeling of how Sites Reservoir and DCP may be operated once they are online circa 2033 (Sites; not specified for DCP in the PA – see BA Section 3.15.7). There are also some specific proposed operating criteria for both facilities in the BA (Tables 3-18 and 3-19). However, due to the framework programmatic nature of this consultation, the Service is treating these as conceptual constructs not proposed operations.

Reclamation and DWR propose to model both of these projects to inform the subsequent consultations. This modeling will be combined and will utilize LTO conditions and criteria as the baseline in order to provide a comprehensive assessment of how operations of these projects are likely to influence the hydrodynamics in the system. This modeling will then be incorporated into a quantitative effects analysis which will focus on key indicators of biological/ecological relevance such as storage, flows, and temperatures at key locations on the Sacramento River, as well as through and downstream of the Delta. The proposed intent is to utilize the proposed operational criteria in the quantitative analysis with the recognition that potential operational refinements will be informed by the programmatic analysis, which will guide subsequent project-level consultations. Adaptive Management is intended to further address outstanding uncertainties up to, and throughout, the operations phase. Implementation goals are included to provide the necessary level of information to inform the subsequent consultations. Since this quantitative information is not yet available, effects to the longfin smelt DPS are not addressed in this BiOp, but will be addressed in the subsequent consultations.

The diversion of Sacramento River water into Sites Reservoir and release of water from it would not in and of themselves have effects on the longfin smelt DPS. The operational effects of Sites Reservoir will depend on the details of how it integrates with existing CVP and SWP facilities and the proposed DCP. The same is largely true of the DCP but operation of the North Delta diversions is likely to have direct effects stemming from entrainment and impingement. Based on this species' historical distribution we expect these impacts to be small relative to exporting water from the South Delta.

Beyond that, the proposed expanded CVP and SWP hydro-system has 3 possible qualitative outcomes for the longfin smelt DPS depending on how it is operated; it could have beneficial effects, no effect, or negative effects. The anticipated direction of effects will largely hinge on what is predicted to occur to Delta outflow. The Service defers all further evaluation of future condition water operations until project specific formal consultation is initiated.

Future considerations

The framework proposed by Reclamation and DWR includes the recognition that there are future regulatory processes and considerations that will influence the initial proposed operational criteria and other aspects of both projects. It will be several years before these projects are constructed and become operational. Section 3.15.1 of the BA outlines foreseeable processes that are ongoing or not yet begun which may result in changes to either or both projects. Results of these processes, including any changes to operational criteria, will be incorporated into the analysis (including quantitative modeling, as necessary) supporting the subsequent consultation processes. In addition, changes to the status and environmental baseline of delta smelt, delta smelt critical habitat, and the longfin smelt DPS will need to be incorporated into future analyses (including quantitative modeling, as necessary). The effects of climate change, delta smelt supplementation, and other factors that are likely to influence the status and baseline of these species and critical habitat will be addressed as well. All of these factors support a framework programmatic approach for both the Sites Reservoir and Delta Conveyance projects.

Adaptive Management

Some of the Adaptive Management Actions (AMAs) are not anticipated to result in activities that may affect listed or proposed species or critical habitat. For instance, actions that only entail database or model development and interpretation; operations that entail modifications (such as timing or magnitude of pulse flows) that are not expected to affect implementation of operational measures designed to avoid or minimize impacts to USFWS jurisdictional species; and monitoring or studies in areas where listed species under USFWS jurisdiction are not expected to be present or otherwise affected.

AMAs that may affect listed species or critical habitat include:

- Summer-fall habitat action for delta smelt
- Efficacy of Suisun Marsh Salinity Control Gate operations
- Experimental Food Enhancement Actions
- Tidal Habitat Restoration Effectiveness
- Longfin Smelt Science Plan Actions
- Delta Smelt Supplementation
- Spring Delta Outflow

See the attached Effects Tracking Table for the species and critical habitat that may be affected by each AMA. Note that these AMAs are also described in the Special Studies section of the BA. The following effects analysis is applicable for both the Adaptive Management and Species Studies sections.

Some of the effects of these AMAs are addressed in separate consultations or permits. In those instances, those separate documents and what they cover are described in the Environmental Baseline section. This BiOp addresses the remainder of effects that are reasonably certain to occur as a result of implementation of the above AMAs. These effects are incorporated as a stand-alone programmatic consultation, as described in the Consultation Approach section.

Summer-Fall Habitat Action for Delta Smelt

The PA includes two types of actions intended to study habitat effects on delta smelt survival and evaluate effectiveness of mitigation actions in improving habitat and food availability. The DCG is the AMT identified to develop the science and monitoring plan for these studies and synthesize information to determine if recommendations for management changes are necessary. The Summer-Fall Habitat Actions are not expected to have effects on the longfin smelt DPS; however, if new studies are conducted that could take fish, then longfin smelt may be incidentally collected in small numbers. The number of longfin smelt that may be incidentally captured or otherwise exposed to these actions is expected to be low.

Tidal Habitat Restoration Effectiveness

Most of the tidal habitat restoration identified in Section 3.7.9 of the PA is constructed or under construction. In order to fulfill its intended two-fold purpose to enhance food production and provide rearing habitat for delta smelt and the longfin smelt DPS, habitat management and monitoring will be implemented and evaluated on a regular basis. Habitat management may include treatment or clearing of invasive vegetation, which could injure or kill longfin smelt in the vicinity of the management activities. These effects will be minimized by the AMT's assessment and planning process. Overall, removal of invasive vegetation is expected to benefit longfin smelt by improving habitat quality. Monitoring will allow assessment of the biotic and abiotic capacity of restored tidal wetlands to support longfin smelt. This is the continuation of ongoing monitoring that historically has captured or otherwise detected relatively few longfin smelt (CDFW 2024). The net export of food web components or contributors from established and managed sites relative to occupied smelt habitats is likely also to be a central component of this monitoring. This information will be synthesized to inform future recommendations for improving restoration sites' ability to produce food for both longfin smelt and delta smelt.

Longfin Smelt Science Plan Actions

There are seven science priority areas identified in the Longfin Smelt Science Plan: (1) Life cycle modeling; (2) Factors affecting abundance, growth, and survival; (3) Improved distribution monitoring; (4) Improved larval entrainment monitoring; (5) Longfin Smelt culture; (6) Fish migration and movements; and (7) Spawning and rearing habitats for Longfin Smelt. The life cycle model will guide implementation of the plan, particularly with respect to new and expanded monitoring.

Some of the actions proposed to be implemented are likely to affect the longfin smelt DPS. As described in the Environmental Baseline section of this BiOp and the Monitoring section of the PA (Section 3.10 of the BA), there are existing consultations that may be utilized to address the effects of new and expanded monitoring. If the effects are different from these existing consultations, Reclamation will initiate consultation consistent with the framework programmatic approach described in Section 3.10 of the BA. Following the principles of this framework will ensure this monitoring will be scientifically robust and improve overall operations of the CVP and SWP, while minimizing effects to the longfin smelt DPS.

Longfin Smelt Culture Program

Section 3.7.11 of the BA describes the purpose and benefits expected from the longfin smelt culture program. As described in the Environmental Baseline section of this BiOp, the effects of broodstock collection for this program are addressed in a separate biological opinion. Research priorities using cultured fish would be guided by the Longfin Smelt Science Team and studies will be in contained conditions. Release of cultured longfin smelt to supplement the wild population was not proposed and, therefore, is not analyzed. If such activities are implemented for the longfin smelt DPS, they would proceed under a Section 10(a)(1)(A) permit for release of listed fish (as the delta smelt is currently undergoing) and would require separate consultation.

Delta Smelt Supplementation

Many planktivorous fish species will opportunistically supplement their diets with larval fish and adult delta smelt are no exception (Hammock *et al*. 2019, p. 863). The expected timing of delta smelt supplementation releases is November through February which includes the months of peak emergence of longfin smelt DPS larvae (Table 10-1). Thus, we expect supplemented delta smelt to consume some longfin smelt larvae. However, we expect the effects of this predation to be extremely small and irrelevant at the population scale because the numbers of delta smelt planned for release are smaller than population numbers generally were prior to about 2015. New findings from the supplementation program will be developed and the supplementation strategy will be updated with performance metrics used to guide production targets and methods development. A process to evaluate production targets to support supplementation will be developed and revisions of production numbers, timeline, release methods, monitoring, and genetic management strategies may be necessary. New or revised monitoring to support the Delta Smelt Supplementation Program that may incidentally capture longfin smelt will be subject to the adaptive management governance process and will either utilize existing consultations or be addressed under the framework programmatic approach in Section 3.10 of the BA.

Spring Delta Outflow

A multi-year evaluation of the performance of increased spring Delta outflows will be conducted to inform the next iteration of the LTO consultation. A draft science plan for the HRL process outlines a framework for assessment variables to determine how to deploy the proposed outflow to maximize benefits to target species, including delta smelt and longfin smelt. Assessment could include biotic and abiotic monitoring to inform performance and future decisions regarding deployment. Through the AMT and HRL governance processes, effects to delta smelt and longfin smelt are expected to be minimized. It is possible that actions to make the water available for outflow may affect species or critical habitat, such as changes to amount or timing of diversions that would have otherwise been used to cultivate rice which is utilized by giant garter snakes. However, there was not enough specific information provided in the BA about what actions would occur to make additional water available to support the spring delta outflow action; therefore, it is too speculative at this time to determine if there will be effects to any listed species or critical habitat from making additional water available. This information will be provided to the Service pursuant to the stand-alone programmatic process described in the Consultation Approach section of this BiOp.

Recovery of the Longfin Smelt DPS

Recovery of listed species is one of the primary goals of the Act. The Act defines ''conservation'' to mean "to use and the use of all methods and procedures which are necessary to bring any endangered species or threatened species to the point at which the measures provided pursuant to this Act are no longer necessary". The regulations implementing section 7 of the Act include conservation and recovery considerations in the definitions. At the species level, to jeopardize the continued existence of a listed species means "to engage in an action that reasonably would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species". Destruction or adverse modification of designated critical habitat means "a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species". In this section, we address the status of development of recovery documents for longfin smelt and how the proposed action impacts recovery efforts.

The Service issued a *Recovery Plan for the Sacramento-San Joaquin Delta Native Fishes* (Recovery Plan) in 1996 (Service 1996). Longfin smelt was not listed at that time; however, the Recovery Plan included it as a species of concern and included recommended restoration criteria for this species.

As part of the process to inform a decision regarding listing the longfin smelt DPS, the Service completed the *Species Status Assessment for the San Francisco Bay-Delta Distinct Population Segment of the Longfin Smelt* (SSA; Service 2024b). The SSA focused on the biological information and threats facing the Bay-Delta DPS to support an in depth review of the species' biology, current and future threats, an evaluation of its biological status, and an assessment of the resources and conditions needed to maintain long-term viability. The intent is for the SSA to be easily updated as new information becomes available and to support all functions of the Service's Endangered Species Program including consultations and recovery actions. As such, the SSA Report will be a living document upon which other documents would be based, such as listing rules, recovery plans, 5-year reviews, and Endangered Species Act §7 or §10 actions. Therefore, while the SSA itself does not contain recovery criteria or needs, it does contain information that can inform recovery planning.

The Service listed the longfin smelt DPS as endangered on July 30, 2024. As part of the listing process, the Service is developing a recovery outline which is a brief document that describes an interim conservation and management program for a species during the time between the final listing and completion of the recovery plan. A recovery outline is intended for use by the Service and guides initial recovery actions and informs other activities, such as section 7 consultations, to support recovery of the species. It is not an outline of a recovery plan. Because a recovery outline is not available at the time of this writing, we are relying on the SSA to inform effects to recovery since it is the most up-to-date document to inform recovery needs.

Effects of the Proposed Action on Recovery

The most probable stressors and environmental variables that have likely led to the DPS's condition and ultimately led the Service to list the DPS as endangered include the following: habitat loss and degradation via reduced freshwater flow, food web effects from reduced flows and invasive species, and increasing temperatures. Other potential stressors include conversion of tidal marsh and environmental contaminants, and more so historically than presently, entrainment via water diversions.

The proposed operation of the CVP and SWP is likely to result in a similar entrainment risk as compared to the NAA. Proposed OMR Management measures in the PA are proposed to minimize the level of entrainment during the period when longfin smelt may be dispersing, spawning and when larvae and juveniles are subject to entrainment by restricting how negative OMR flows can be during these life stages. The inclusion of a comprehensive OMR management strategy in the PA will be very protective of the longfin smelt DPS because longfin smelt are typically more seaward than delta smelt at this time making them less vulnerable to entrainment. Since the onset of OMR protective measures in 2009, entrainment risk has not been substantial enough to affect the population dynamics of the DPS.

The proposed spring delta outflow/HRL element will likely have incremental beneficial effects on the longfin smelt DPS as compared to the NAA. However, if the Spring Delta Outflow proposed in the HRL program is not implemented, the PA will likely have incremental negative effects on the longfin smelt DPS as compared to the NAA. Therefore, effects to recovery as it relates to reduced freshwater outflow will depend on if the HRL is adopted and implemented as proposed.

Reclamation and DWR are proposing measures to minimize the adverse effects of accumulating loss and degradation of habitat to promote the recovery of the longfin smelt DPS. The proposal to finish restoring intertidal and associated subtidal habitat in the Delta and Suisun Marsh, protecting and managing this habitat in perpetuity, and ensuring these restored sites are effectively functioning for the intended purpose may benefit the longfin smelt DPS. Reclamation and DWR commit to ensuring that monitoring, operation, maintenance, and permanent protection occur on these restored lands. An overall monitoring program developed to focus on the effectiveness of the restoration actions will inform future actions undertaken for the intended food web benefit of Delta Smelt. The Service is a member of the FAST, which assists DWR in designing the proposed restoration projects to increase food web production in appropriate locations to benefit the target species.

The PA may minimize the effects to two of the most significant known stressors to the species: habitat loss and degradation via reduced freshwater flow via the Spring Delta Outflow element, and food web effects from reduced flows and invasive species via the tidal habitat restoration element. We do not have a guiding recovery document as of this writing, but based on the effects described above, overall the PA is not likely to preclude recovery of the longfin smelt DPS.

e. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect the longfin smelt DPS in the same manner. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the DPS.

Summary of Aggregated Effects

Effects of the Aggregate Status of the Species/Environmental Baseline, and Proposed Action for Longfin Smelt DPS

The purpose of the aggregate analysis is to evaluate the combined status and baseline of the species, the effects of the PA and the cumulative effects of non-Federal activities to determine their combined effects to the DPS. Reclamation has committed to implementing programmatic actions that will be subject to future consultation, so those effects have been analyzed at a general level since specific details about those activities have not yet been developed, and the analyses of those actions at this stage are focused on the proposed frameworks for the future consultations. Subsequent consultation on those activities will include analyses of effects at a more specific level and will address incidental take of listed species if it is reasonably certain to occur.

As discussed in the *Environmental Baseline* section of this BiOp, the Environmental Baseline does not include the effects of the action under review in the consultation. We have largely incorporated by reference the *Environmental Baseline* from the BA. The *Environmental Baseline* section describes factors that have led to the current condition of the longfin smelt DPS, including past operations of the CVP and SWP, habitat restoration, and other effects from Federal, State, and private actions. Notably, since the longfin smelt was listed under CESA in 2009, the SWP has implemented measures to minimize the effects of their water operations since that time. Further, as described in the effects analysis, measures to protect other listed fish from water operations have also benefitted the longfin smelt DPS which has resulted in reduced entrainment levels that have not been substantial enough to affect the species population dynamics and have been an effective conservation strategy for this species in the Bay-Delta (Service 2024b). In addition, CDFW, DWR, the State Water Contractors and the Service have partnered to design and implement the Longfin Science Plan, which contains seven priority science areas that are and will continue to be implemented to inform and improve management decisions for the DPS.

Summary of the Status of the Species

The Action Area for this consultation encompasses the entire range of longfin smelt that complete their life cycle in the San Francisco Bay-Delta. The longfin smelt DPS has been in general decline for many decades due mainly to alterations of the estuary flow regime and food web (see Service 2024b for further details). A population viability analysis of the DPS indicated it had a high risk of quasi-extinction in the near future (2025-2040; Tobias *et al.* 2023).

The anticipated effects of climate change on the Bay-Delta and its watershed such as warmer water temperatures, greater salinity intrusion, lower snowpack contribution to spring outflow, and the potential for frequent extreme drought, indicate challenges to longfin smelt survival that are already concerning will further intensify.

A No Action Alternative scenario has been incorporated into our effects analysis to aid in identifying aggregate effects (including identifying future effects of the PA components that have not changed from current operations, as well as identifying effects of the components of the PA). The NAA essentially represents current operations of the CVP and SWP. Where adverse effects of the PA are expected to increase relative to current operations, those increases and to which life stages they occur, have been explained in our effects analysis.

Where beneficial effects of the PA may or are likely to occur, those have also been explained. Where it is currently unknown what effects will occur because of a lack of specific information about how the action will be implemented, those have also been noted. There have also been numerous other factors that have affected the longfin smelt DPS in addition to operations of the CVP and SWP.

Therefore, the summary of aggregate effects to the longfin smelt DPS described below for use in considering whether or not the PA is likely to jeopardize the longfin smelt DPS (pursuant to the *Analytical Framework for the Jeopardy Determination*) reflect our consideration of the effects of the PA in light of all of the factors leading to the current condition of the DPS, including the effects of past and current operations of the CVP and SWP and cumulative effects.

Summary of the Effects of the PA on the Reproduction, Numbers, and Distribution of Longfin Smelt

As noted in the *Effects of the Action* section above, the DPS has been in decline for many decades, which has led to its recent listing as endangered. A significant stressor that has led to the current condition of the DPS has been a reduction in the magnitude and duration of freshwater flows into and through the Delta (Service 2024b). Water storage and diversion through Central Valley watersheds has decreased springtime flows resulting from upstream storage, and increased summer inflows that are subsequently diverted for urban and agricultural beneficial uses (Kimmerer 2004, p. 15). From 1956 to the 1990s, water exports increased, rising from approximately five percent of the Delta inflow to approximately 30 percent of the Delta inflow (Cloern and Jassby 2012, p. 7). By 2012, an estimated 39 percent of the estuary's unimpaired flow in total was either consumed upstream or diverted from the estuary (Cloern and Jassby 2012, p. 8).

The proposed operations will not eliminate the entrainment of the longfin smelt DPS, but they should help to keep it similar to the low levels that have occurred since 2009 when the SWP began implementing measures to minimize the effects of operations. This was also around the time that OMR management rules for the CVP and SWP first came into full effect for delta smelt. Although there is overlap in the spatial distributions of the longfin smelt DPS and delta smelt during the winter and spring, the average location of the longfin smelt DPS is seaward of the average location of a delta smelt (e.g., Dege and Brown 2004, their Fig. 3). Therefore, the inclusion of a comprehensive OMR management strategy in the PA means that at the scale of these two somewhat co-occurring fish populations, any given OMR restriction will be even more protective of the longfin smelt DPS than delta smelt because proportionally more of the longfin smelt DPS are outside of the hydrodynamic influence of the Banks and Jones pumping plants.

Reproduction

Operations of the CVP and SWP as described in the PA will have impacts to longfin smelt reproduction. Favorable Delta outflow conditions in the winter and spring months are critical to successful reproduction. Longfin smelt larvae hatch predominantly from within the low-salinity zone and become part of the plankton community both within the low-salinity zone and to a lesser degree, in adjacent lower and higher salinity habitats. Larval longfin smelt can also hatch from tributaries to San Francisco Bay when flows out of those tributaries are high (Lewis et al. 2021 p. 3; Gross *et al*. 2022, p. 187). Larvae hatching from these tributaries are not vulnerable to exports from the Delta. To be vulnerable to entrainment in exported water, the larvae have to either have been spawned in the South Delta or transported there by a combination of tidal and net river flow currents (Gross et al. 2022, entire). The salinity range defining the low-salinity zone is an approximate description of a dynamic habitat, and longfin smelt are collected across a wider range of salinity. Given the OMR protective measures in the PA are expected to reduce the likelihood of entrainment of adult longfin smelt into the South Delta, a relatively small proportion of the overall population of larvae that would have hatched are likely to be entrained and lost to the overall population.

Numbers

By operating the existing CVP and SWP export facilities, there is ongoing potential risk to longfin smelt individuals (especially larvae, juveniles, and adults) from entrainment or impingement and increased predation rates. The proposed OMR management strategy generally conforms to current best available information by combining limits on how negative net OMR flow can be with turbidity triggers. As mentioned above, entrainment of longfin smelt affects individuals, but current best available information indicates to us that it does not affect population dynamics of the DPS. Overall, entrainment of longfin smelt is anticipated to be minimized by the multispecies collection of OMR management strategies. The intent of actions slated from December through June will be to minimize the effect of entrainment to adult longfin smelt dispersing into the South Delta, which will minimize the number of entrained individuals and their progeny that are subjected to entrainment, poor habitat conditions and predation. These proposed operations will not eliminate subadult and adult longfin smelt entrainment, but they should help to keep it at low levels similar to what has occurred since 2009 when OMR management first came into full effect.

The spring Delta outflow proposed in the HRL will likely have incremental beneficial effects on the longfin smelt DPS as compared to the NAA. It has been long recognized that the abundance of longfin smelt increases as a function of wet season Delta outflow or its corollary, X2 (Stevens and Miller 1983, their Table 8; Jassby *et al.* 1995, their Fig. 5; Thomson *et al*. 2010, their Fig. 6). By extension this means that early life survival tends to increase with increasing Delta outflow (Service 2024b, p. 28). The timing of when the wet season flows are most important was recently suggested to be after March (Kimmerer and Gross 2022, p. 2741). However, the analysis from the BA suggests that the timing of the effect of outflow on the longfin smelt DPS survival may retain some important uncertainty. CalSim 3 modeling suggests the statistical distributions of Delta outflow in the spring months would remain very similar to the NAA and Reclamation concluded that given uncertainty in longfin smelt abundance predictions, the modeled variations of Alternative 2 do not produce distinguishable results. We ran an experiment and determined that the full HRL (Alt2v3) is predicted to incrementally increase the abundance of the longfin smelt

DPS, the exports only HRL (Alt2v2) is predicted to more or less maintain a status quo, and the no HRL alternatives are predicted to increase the rate of decline in the DPS. If the Spring Delta Outflow proposed in the full HRL program is not implemented, the PA will likely have no discernable effect or incremental negative effects on the longfin smelt DPS as compared to the NAA. The post-adoption proposal of the HRL is addressed as a framework programmatic action; therefore, the information in this BiOp will help inform a subsequent consultation, consistent with the framework described in *Spring Delta Outflow/Healthy Rivers and Landscapes Program* subsection of the *Consultation Approach* section of this BiOp, if the HRL as proposed is approved and incorporated into SWRCB's WQCP.

Distribution

The PA is not expected to change the spatial distribution of the longfin smelt relative to the NAA except when HRL outflow augmentations are occurring. OMR management is anticipated to help minimize the loss of the larval and juvenile life stage to levels similar to the NAA. As described above, any given OMR will be more protective of the longfin smelt DPS than delta smelt because proportionally more of the longfin smelt DPS are outside of the hydrodynamic influence of the Banks and Jones pumping plants given their more typical seaward distribution. The OMR protective measures in the PA are expected to reduce the likelihood of entrainment of adult, larval, and juvenile longfin smelt into the South Delta, resulting in a relatively small proportion of the overall population likely to be entrained and lost to the overall population.

Other factors that may affect longfin smelt DPS distribution include the operation of the agricultural barriers. Occasionally, adult fish may come into contact with these structures as they are moving upstream, but this possibility is low given that the agricultural barriers are put into place relatively late (April) when most adult longfin smelt have already spawned and died. Larval distributions will be affected much more by Delta outflow than the operation of the temporary barriers or OMR. Based on historical distribution, it is unlikely that South Delta barriers will affect any individuals that were not already entrained into Old and Middle rivers. Individuals encountering the agricultural barriers may be precluded from moving within the channel and made more vulnerable to predators hovering around the barriers and gates, but these fish were already assumed to be entrained or lost to predators in our effects analysis.

It is unknown what (if any) effects the DCC operations have on the longfin smelt DPS. Adult longfin smelt and their progeny have occasionally been collected in the vicinity of the DCC (Merz *et al*. 2013, their Fig. 5), but the Service considers this a transiently used area that supports a small fraction of total spawning. Opening and closing the DCC gates in December or January may change where these longfin smelt end up, but it is not known whether such relocation has a consequence to survival. It is likely that larvae hatching along the Sacramento River upstream of the DCC will more or less be passively distributed downstream, and are more likely to be entrained if the gate is open. The Service has no information to suggest that in and of itself this redistribution will result in negative effects. However, this is anticipated to be of no population consequence given longfin smelt's infrequent use of the area influenced by the DCC gates; although operation of the DCC may result in the transport of a few larvae into the South Delta.

Longfin smelt use the estuary very differently than delta smelt. A fundamental difference is the seasonality of the longfin smelt DPS's distribution in the estuary. By July, when the SMSCG would begin to be operated, the distribution of the longfin smelt DPS is not constrained by an upper salinity bound. Thus, the marsh provides rearing habitat for longfin smelt with or without the SMSCG action.

When longfin smelt begin returning to the estuary in the fall, distribution is broad but is influenced by X2 (CDFW 2020, their Fig. 2). However, there is no information available to indicate that the location of X2 affects survival of fish by this stage in their life beyond potentially affecting the risk of entrainment, which our effects analysis suggests is very minor. We do not anticipate that the Delta Smelt Summer-Fall Habitat Action will have discernable effects on the longfin smelt DPS.

As proposed by Reclamation and DWR, the remainder of the 8,396.3 acres of restored habitat will be constructed, protected and managed by 2026. It is anticipated that this habitat will function as originally outlined in the 2008 BiOp and reiterated in the 2019 BiOp including food web benefits. These restoration projects are sited in areas designed to maximize food production and distribution to areas where longfin smelt would benefit from access to it and also to improve amount and distribution of rearing habitat for longfin smelt. In addition, tidal habitat effectiveness monitoring is now proposed as an adaptive management action to further ensure these projects function into the future and take actions to improve their functionality if necessary.

Overall, while the PA will result in certain negative effects to the reproduction, numbers and distribution of the longfin smelt DPS, it may also result in beneficial effects through protective real-time operations actions, habitat restoration, and potential spring outflow augmentation.

Conclusion

After reviewing the current status of the longfin smelt DPS, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the longfin smelt DPS. We have reached these conclusions because:

- Implementation of the OMR management actions in the PA are designed to minimize impacts to longfin smelt, primarily through minimization of entrainment of migrating adult longfin smelt and their progeny. This will result in a relatively small proportion of the overall population of longfin smelt being entrained and lost to the overall population by being subject to poor habitat conditions and predation. These protective actions are designed to prevent conditions which are conducive to entrainment.

- The pre-adoption export reductions of the Spring Delta Outflow component of the PA will likely maintain the status quo in terms of abundance of the longfin smelt

DPS. If the HRL is adopted, then the post-adoption outflows in the spring are likely to provide incremental benefits in terms of species abundance.

- Completion of construction, protection, and management of tidal habitat restoration projects will benefit longfin smelt because they are sited in areas designed to maximize food production and distribution to areas where longfin smelt would benefit from access to it and also to improve amount and distribution of rearing habitat for longfin smelt.

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11. Northwestern Pond Turtle

a. Status of the Species

On October 3, 2023, a proposed rule to list the northwestern pond turtle as threatened with a 4(d) rule was published in the Federal Register (88 FR 68370-68399). At this time, a final listing determination has not been issued. As such, the following is a conference opinion of the effects of the PA on the northwestern pond turtle pursuant to section 7(a)(4) of the Act. The proposed listing rule can be found at https://www.govinfo.gov/link/fr/88/68370. Please refer to the 2023 Special Status Assessment (pond turtle SSA; Service 2023) prepared for this rule for the species' description, habitat preference, and life history found at https://ecos.fws.gov/ServCat/DownloadFile/241273.

b. Status of the Critical Habitat

Critical habitat has not been proposed for the northwestern pond turtle.

c. Environmental Baseline

Northwestern pond turtle (pond turtle) are aquatic turtles that are found throughout the Action Area. They utilize both the rivers and reservoirs associated with the PA. Much of the decline of numbers of pond turtles is a consequence of what is now baseline. Diversions, dams and operations of the CVP and SWP are a significant reason for the decline of pond turtles in California, resulting in fragmented habitat and invasive species that outcompete and predate on pond turtles.

Please refer to the 2023 pond turtle SSA (Service 2023) for additional information on the conditions that led to the decline.

d. Effects of the Action

Several threats have been identified through the listing process that may negatively affect the pond turtle. The threats that are relevant to the PA include continued degradation of habitat, operations and maintenance of CVP and SWP facilities, groundwater depletion, predation, and competition.

Operations and Maintenance of Facilities

Dispersal of western pond turtles between populations/watersheds is generally not well understood. Genetic analyses suggest that most movements occur within drainages (Spinks and Shaffer 2005, p. 2057), but few accounts of adult and juvenile dispersal exist. Within aquatic habitat, a dispersal distance of 7 km upstream was observed (5 km overland distance) (Holland 1994, p. 7-28). Dispersal may also occur via aquatic habitats during flood events (Rosenberg *et al.* 2009, p. 21). Along the central California coast, Holland (1994, p. 2-9) recorded less than 10 dispersal events between drainages during a 10-year study with over 2,100 captures and recaptures across 21 drainages, suggesting that overland movements are uncommon. In that study, the longest overland distance recorded in an area considered to be under the best circumstances (mild climate and short distances between water features), was a single individual travelling 5 km. Holland (1994, p. 2-9), also states that no movements between drainages were detected from three other sites with over 1,100 hundred captures and recaptures over a 7-year period. During an extreme drought, Purcell *et al.* (2017, pp. 21, 24) documented a 2.6 km straight-line distance movement overland in a radio-tagged turtle, with a minimum total distance of 3.3 km moved before the individual found water.

Aquatic Effects

Because pond turtles are potentially present in and around CVP and SWP facilities, individual pond turtles will likely be impacted by operations and maintenance activities. While many of these impacts will be sublethal, such as being disturbed to where they move off basking sites, many other impacts are likely to cause direct and indirect mortality of individuals. Operational effects that may kill or injure pond turtles include going over operating spillways, going through intakes, or being entrained in the South Delta and ending up in the fish salvage facilities.

While most of the degradation of the pond turtle habitat throughout the system has already occurred and is included in the Environmental Baseline for the pond turtle, altered hydrology can be exacerbated or may be compounded by other threats to the species, such as drought and nonnative predators. During drought years, aquatic habitat within water storage reservoirs or dams upstream are more likely to go dry (Meyer et al. 2003, p. 2). For example, in southern California there is often reduced water availability in streams below dams where water is held back and diverted (Madden-Smith et al. 2004, p. 14; Madden-Smith et al. 2005, p. 5). Long-term water extractions/diversions/pumping on streams function similarly to the stream drying that occurs during extended droughts in the way they affect western pond turtles (see Drought section below). Hydrologic infrastructure and management have also been associated with the success of introduced fishes and amphibians (see *Nonnative Predators* section), many of which compete with and prey on native wildlife including western pond turtles (Moyle 1973, p. 21; Holland 1991, pp. 54–57; Holland 1994, pp. 2-11–2-12; Hays et al. 1999, pp. 13–14; Spinks et al. 2003, pp. 264–265; Cadi and Joly 2004, pp. 2515–2517).

Terrestrial Effects

Some individuals will be stranded due to changes in hydrology/dewatering of habitat and face an increased likelihood of predation from mesopredators often found in and around ruderal communities surrounding infrastructure.

CVP and SWP infrastructure is within the dispersal range of pond turtles. It is inevitable that they will traverse roads and trails and/or become stranded by barriers to dispersal. While it is not anticipated that road strikes and stranded turtles will be common, due to the size of the overall Action Area, the likelihood of pond turtles being present in or near the infrastructure, and the duration of the Projects, strikes and strandings are likely to occur. The frequency of these interactions is unknown and was not provided. These interactions are presumed to be infrequent. Reclamation and DWR have proposed providing worker awareness training programs for federally listed species, which will include information about northwestern pond turtle, at the Delta Cross Channel facility, Tracy Fish Facility, Clifton Court Forebay facility and Barker Slough facility. They have also proposed to move any pond turtles that are observed to be in harm's way in and/or adjacent to the Delta Cross Channel Facility, Tracy Fish Facility, Clifton Court Forebay Facility and Barker Slough to the nearest habitat and notify the Service. These measures will reduce the likelihood of pond turtles being injured during operations or maintenance activities. Implementing this minimization will reduce the expected impact to the species and inform the Service of the frequency of interactions.

Drought Actions

One of the primary tools used in dry water years to protect reservoir capacity and water quality, is the curtailment of water deliveries. These curtailments often cause water users to turn to groundwater pumping to make up the loss of water. No description of the magnitude of groundwater pumping during these actions was provided.

Lentic aquatic habitat used by western pond turtles is supported and supplemented by groundwater (Rhode et al. 2019, p. 220). Because groundwater and stream surface-water systems are connected, groundwater pumping and surface water diversions threaten western pond turtle habitat by depleting water, reducing the amount and duration of surface flows in streams, and further fragmenting available habitat. For example, groundwater pumping has depleted perennial aquatic habitat in the Mojave River, resulting in southwestern pond turtles using artificial ponds and traveling long distances to nest; no juveniles were detected in 1998/1999 despite radiographs of shelled eggs and documented nesting migrations (Lovich and Meyer 2002, pp. 541–543).

e. Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area and are considered in this biological opinion. Future Federal actions unrelated to the PA are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

The overwhelmingly predominant land use within the Action Area is some form of agriculture, whether that be row crops, orchards, dry farming, livestock grazing, etc. It is reasonable to assume that all effects to federally listed species that are associated with the agricultural activities that currently occur in the Action Area will continue to occur. The Service assumes that these ongoing, background effects from agricultural practices within the Action Area will remain throughout the life of the PA and it would be very difficult to quantify or predict the nature that they will take throughout the life of the PA. These agricultural practices do constitute a cumulative effect. Beyond these ongoing agricultural activities, we are unaware of any specific future State, Tribal, local, or private actions that may affect the northwestern pond turtle and are reasonably certain to occur in the Action Area.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species in the following sections. In that context, the following paragraphs summarize the effects of the PA on the northwestern pond turtle.

Reproduction

The pond turtle is found throughout the Action Area. The PA may reduce local reproduction as reduced connectivity between populations is likely to interfere with pond turtle fecundity. It is anticipated that the effects will not reduce the range-wide reproductive capacity of the species. Nests are typically built in the Late Spring / Summer, and hatchlings emerge in the late summer and early fall (Service 2023). Reservoirs are typically at their highest in late spring and drawn down over the summer. This would not inundate nests in the uplands, and effects would be limited to the increased distance hatchlings would have to travel to get to the water.

Numbers

The pond turtle is a widely distributed but uncommon species. We anticipate the PA is likely to result in adverse effects to the pond turtle. It is unclear the degree the PA will interact with the pond turtle due to lack of protections. However, it is not anticipated to reduce the pond turtle numbers outside of the Action Area and we conclude that the overall number of pond turtles throughout the species' range is not expected to decline due to the PA. Much of the decline has already taken place as is described in the SSA and is considered baseline.

Distribution

The full extent and range of pond turtle is reasonably understood; however, the frequency of interactions from the CVP and SWP is not due to the lack of previous protections, the Service anticipates that the PA will not alter the distribution of the pond turtle beyond the fragmentation that has already occurred prior to listing and included in the environmental baseline and described in the SSA (Service 2023), and we do not expect Reclamation's actions will further reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of the northwestern pond turtle, the Environmental Baseline for the Action Area, the effects of the PA and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- The number of the northwestern pond turtles likely to be adversely affected by the PA is low. This is because the PA elements affecting Pond Turtle have not changed significantly and it is presumed much of the effects of the PA are considered baseline and occurred prior to listing. These are detailed in the Services SSA supporting the listing decision (Service 2023).

- Although it represents a fraction of the species' historical range, northwestern pond turtles are distributed throughout the Action Area, and the presence of many populations provide some degree of resiliency. It is anticipated with listing and protections, the populations of Pond Turtle will be better defined.

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12. Riparian Brush Rabbit

a. Status of the Species

The Service listed the riparian brush rabbit as an endangered species on February 23, 2000 (Service 2000). The *Recovery Plan for Upland Species of the San Joaquin Valley,* which included the riparian brush rabbit as a covered species, was published on September 30, 1998 (Service 1998). The most recent 5-year review was conducted in 2020 where no change of status was recommended (Service 2020) and the Final Species Status Assessment for the Riparian Brush Rabbit was published on June 12, 2020 (Service 2020a) which provides a comprehensive review of the riparian brush rabbit. Please refer to the 2020 Species Status Assessment for the species' description, habitat preference, and life history.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

c. Environmental Baseline

The current distribution of the riparian brush rabbit is limited to southern San Joaquin County and northern Stanislaus County. The subspecies resides in brushy vegetation associated with riparian areas along the Old, Stanislaus, Tuolumne, and San Joaquin rivers. The current distribution also includes brushy vegetation along Paradise Cut, Tom Paine Slough, and a small section of the Union Pacific Railroad right-of-way. In addition to the aforementioned areas, two rabbit carcasses were collected along the Middle River during March of 2017. On October 16, 2019, the Service received genetic confirmation that the carcasses were riparian brush rabbits (Matocq 2019, in litt.). This new information indicates that there may be additional, undocumented occurrences of riparian brush rabbit in San Joaquin County. However, there is no additional information on the historical or current status of riparian brush rabbit presence in this area or on the genetic-relatedness of the carcasses to nearby populations. It is currently unknown whether the area along the Middle River supported or supports a breeding riparian brush rabbit population or if the carcasses were incidental observations of dispersing rabbits.

The Caswell Memorial State Park population along the Stanislaus River is within the southern boundary of the Action Area. The best available information suggests that the Caswell riparian brush rabbit population has low abundance and low growth rate. Drastic population reductions, caused by flood events, have occurred in this population. The South Delta populations of riparian brush rabbit, which includes Paradise Cut and Tom Paine Slough, are within the Action Area. There is little information available as to the status of these populations as no comprehensive surveys for riparian brush rabbit have been conducted in these areas. The Oxbow Preserve (Preserve) is a 30-acre preserve established specifically to protect the riparian brush rabbit and is located along the San Joaquin River near the City of Lathrop. The Preserve riparian brush rabbit population has not been surveyed to estimate population size. Therefore, the current condition of abundance is unknown. However, the amount of habitat available at the Preserve would indicate that population abundance is less than 200 individuals. Therefore, the current condition of abundance for the Oxbow population was ranked as low (Service 2020).

Although no rabbit surveys were conducted specifically for the PA, riparian woodland habitat is located within the Action Area and numerous sightings have been made in close proximity to the West Stanislaus Irrigation District intake canal. Approximately 0.84 acre of riparian woodland with thickets of willows and shrubs occur within the Action Area, with ruderal habitat comprising the majority of the balance of the upland areas within the Action Area. It is reasonable to assume that the riparian woodland present overlaps the home range of at least one riparian brush rabbit.

The Service has formally consulted on several projects within the Action Area since 2019 that may adversely affect the riparian brush rabbit including the Lathrop Consolidated Treatment Facility Surface Water Discharge Project (08FBDT00-2021-F-0122).

d. Effects of the Action

The riparian brush rabbit occurs in the Stanislaus River and San Joaquin River watershed, and PA components within these watersheds may affect this species as follows.

Flow and Operations

Operations under the PA will include hydrologic changes associated with water manipulation; topographic changes associated with flood control; agriculture; and biological changes associated with the introduction of non-native species caused by implementation of the PA. Implementation of the PA generally will result in minor changes to flow and likely will be small relative to normal month-to-month and year-to-year variability in the system. Any changes in the natural flow regime of the river will likely result in an increase in non-native and invasive plant species and a reduction in native riparian vegetation recruitment. Lower flows in the spring under the PA are likely to result in less riparian vegetation recruitment which could result over the duration of the PA in less habitat used for cover for riparian brush rabbit which would reduce opportunities for sheltering. Lower flows in the spring and a more stable regime are likely to reduce the amount of surrounding suitable habitat over time. Any changes to the habitat surrounding existing populations of riparian brush rabbits may adversely affect their ability to disperse and colonize new areas beyond the current habitats occupied. The changes in flow and operations are unlikely to directly affect individual riparian brush rabbits, but may result in indirect impacts over time through negative changes in riparian habitat resulting in unsuitable habitat for the species. It is not expected that the magnitude and rate of this impact will affect breeding or feeding during the timeframe of the PA but may reduce sheltering opportunities. However, the potential impacts are not reasonably certain to result in take of the species.

Effects to Recovery

Based on the evaluation of effects described above, there is the potential to reduce or modify the amount of riparian habitat as a result of the PA; however we do not anticipate the PA would prevent recovery actions identified in the species' Recovery Plan or interfere with State Park management, Federal Wildlife Refuge management, or ongoing and future restoration efforts where riparian brush rabbits are found. Therefore, the Service does not anticipate that the PA would prevent the recovery of the riparian brush rabbit.

e. Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area and are considered in this biological opinion. Future Federal actions unrelated to the PA are not considered in this section because they require separate consultation pursuant to section 7 of the Act.

The overwhelmingly predominant land use within the Action Area is some form of agriculture, whether that be row crops, orchards, dry farming, livestock grazing, etc. It is reasonable to assume that all effects to federally listed species that are associated with the agricultural activities that currently occur in the Action Area will continue to occur. The Service assumes that these ongoing, background effects from agricultural practices within the Action Area will remain throughout the life of the PA and it would be very difficult to quantify or predict the nature that they will take throughout the life of the PA. These agricultural practices do constitute a cumulative effect. Beyond these ongoing agricultural activities, we are unaware of any specific future State, Tribal, local, or private actions that may affect the riparian brush rabbit and are reasonably certain to occur in the Action Area.

f. Summary of Aggregated Effects

In determining whether a proposed action likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the riparian brush rabbit.

<u>Reproduction</u>

The riparian brush rabbit is a secretive and hard-to-detect species that is limited within the Action Area. The PA may cause adverse effects to reproduction through the degradation of habitat over time and the reduction of sheltering opportunities. There is no mechanism by which to foresee how the riparian brush rabbit would respond or adapt to a loss of sheltering habitat or how it would affect the rabbit's reproductivity, but the Service anticipates the effect to be low. Therefore, the PA is not expected to appreciably affect riparian brush rabbit reproduction, and we conclude that the effects would not significantly reduce the range-wide reproductive capacity of the species.

Numbers

The number of riparian brush rabbits in the Action Area is relatively low, based on recent and past records (Service 2020a). The Service anticipates that the PA may result in effects to the riparian brush rabbit due to the continued degradation of riparian habitat; however, the number of riparian brush rabbits affected would be very low. This is especially true relative to the range-wide numbers. Therefore, the PA is not expected to reduce the number of riparian brush rabbits throughout the species' range.

Distribution

The Service anticipates the number of riparian brush rabbits likely to be affected by the PA will be very low. We do not expect that any riparian brush rabbits will be directly killed or harmed by any of the actions associated with the PA. We also conclude that riparian brush rabbits will continue to survive in the Action Area regardless of the activities. We do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of the riparian brush rabbit, the Environmental Baseline for the Action Area, the effects of the PA and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- The number of riparian brush rabbits likely to be affected by the PA will be very low, and take of the species is not reasonably certain to occur.

h. References

(Service) U.S. Fish and Wildlife Service. 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Region 1, Portland, Oregon. 319 pp. https://ecos.fws.gov/docs/recovery_plan/980930a.pdf

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Matocq, M. 2019. University of Nevada Reno. Riparian brush rabbit. Email to Joshua Emery of the U.S. Fish and Wildlife Service.

13. Riparian Woodrat

a. Status of the Species

The Service listed the riparian woodrat as an endangered species on February 23, 2000 (Service 2000). The *Recovery Plan for Upland Species of the San Joaquin Valley,* which included the riparian woodrat as a covered species, was published on September 30, 1998 (Service 1998). The most recent 5-year review was completed in September 2020 where no change in status was recommended (Service 2020). Please refer to the 2020 5-year review for the species' description, habitat preference, and life history.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

c. Environmental Baseline

The Caswell Memorial State Park (CMSP) population along the Stanislaus River is within the southern boundary of the Action Area. No research has been conducted on the spatial distribution and habitat use of the riparian woodrat, but it likely has similar spatial distribution patterns of the dusky-footed woodrat, of which it is a subspecies. Territories of dusky-footed woodrats in the mixed conifer forests of the northern Sierra Nevada, California ranged from 0.14 to 18 acres (Innes *et al.* 2009).

The specimens from which the subspecies designation was described were collected about 2 miles (3 km) northeast of Vernalis, west of Modesto in Stanislaus County, California, approximately 6 miles (10 km) from CMSP. Analysis of DWR land use maps indicate that there were approximately 50 acres (20 hectares) of "natural vegetation" present along the San Joaquin River near the locality in 1988, though no riparian woodrats have been seen in that area. Today there is no habitat for riparian woodrats around El Nido, which is located about 5.5 miles (8.9 km) east of the San Joaquin River.

Also within the Action Area, the San Joaquin River National Wildlife Refuge (SJRNWR) population may be quite vulnerable: only 34 individuals have been captured (at different times) and no stick lodges have been observed anywhere on the refuge, although riparian woodrat are known to use downed trees, snags, or even buildings in place of constructing stick lodges (Kelly *et al.* 2011). Additionally, a wildfire event in 2004 and major flood events in 2006 and 2011 may have significantly reduced the SJRNWR riparian woodrat population (Kelly *et al.* 2011).

Since 2011, six riparian woodrats were caught during a December 2012 trapping survey at CMSP (Kelly *et al.* 2014). One of the captured riparian woodrats had also been caught in a previous survey at CMSP four years earlier. No additional trapping efforts have been conducted at CMSP since that time (Reith in litt. 2019). A single riparian woodrat was also captured at SJRNWR in May 2012 incidental to reintroduction and monitoring efforts for riparian brush rabbit (*Sylvilagus bachmani riparius*) (Kelly *et al*. 2014). A 2017 biological assessment of potential impacts from restoration on lands adjacent to the SJRNWR notes riparian woodrat had been captured at the refuge in 2005, 2009, 2011, and 2012, but mentions no subsequent captures (River Partners 2017). However, automatic cameras set up on the refuge for a master's thesis study on riparian brush rabbits obtained over 300 pictures of riparian woodrats at 6 locations during the spring and summer of 2017 (Tarcha 2020).

The Service has formally consulted on several projects within the Action Area that may adversely affect the riparian woodrat including the SR 99 Ripon Bridge Rehabilitation Project in San Joaquin and Stanislaus counties (08ESMF00-2015-F-1164-R003).

d. Effects of the Action

The riparian woodrat occurs in the Stanislaus River and San Joaquin River watershed, and PA components within these watersheds may affect this species as follows.

Flow and Operations

Operations under the PA will include hydrologic changes associated with water manipulation; topographic changes associated with flood control; agriculture; and biological changes associated with the introduction of non-native species caused by implementation of the PA. Implementation of the PA generally will result in minor changes to flow and likely will be small relative to normal month-to-month and year-to-year variability in the system. Any changes in the natural flow regime of the river will likely result in an increase in non-native and invasive plant species and a reduction in native riparian vegetation recruitment. Lower flows in the spring under the PA are likely to result in less riparian vegetation recruitment which could result over the duration of the PA in less habitat used for cover for the riparian woodrat which would reduce opportunities for sheltering. Lower flows in the spring and a more stable regime are likely to reduce the amount of surrounding suitable habitat over time. Any changes to the habitat surrounding existing populations of riparian woodrat may adversely affect their ability to disperse and colonize new areas beyond the current habitats occupied. The changes in flow and operations are unlikely to directly affect individual riparian woodrats, but may result in indirect impacts over time through negative changes in riparian habitat resulting in unsuitable habitat for the species. However, it is not expected that the magnitude and rate of this impact will affect breeding, or feeding during the timeframe of the PA. Although adverse effects to the riparian woodrat's habitat may occur, the potential impacts are not reasonably certain to result in take of the species.

Effects to Recovery

Based on the evaluation of effects described above, there is the potential to reduce or modify the amount of riparian habitat as a result of the PA; however, we do not anticipate the PA would prevent recovery actions identified in the species' Recovery Plan or interfere with State Park management, Federal Wildlife Refuge management, or ongoing and future restoration efforts where riparian woodrats are found. Therefore, the Service does not anticipate that the PA would prevent the recovery of the riparian woodrat.

e. Cumulative Effects

Cumulative effects include the effects of future State, Tribal, local, or private actions that are reasonably certain to occur in the Action Area considered in this biological opinion. Future Federal actions unrelated to the PA are not considered in this section, because they require separate consultation pursuant to section 7 of the Act.

The overwhelmingly predominant land use within the Action Area is some form of agriculture, whether that be row crops, orchards, dry farming, livestock grazing, etc. It is reasonable to assume that all effects to federally listed species that are associated with the agricultural activities that currently occur in the Action Area will continue to occur. The Service assumes that these ongoing, background effects from agricultural practices within the Action Area will remain throughout the life of the PA and would be very difficult to quantify or predict the nature that they will take throughout the life of the PA. These agricultural practices do constitute a cumulative effect. Beyond these ongoing agricultural activities, we are unaware of any specific future State, Tribal, local, or private actions that may affect the riparian woodrat and are reasonably certain to occur in the Action Area.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to the reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the riparian woodrat.

Reproduction

The riparian woodrat is a secretive and hard-to-detect species that is limited within the Action Area. The PA may cause adverse effects to reproduction through the degradation of habitat over time and the reduction of sheltering opportunities. There is no mechanism by which to foresee how the riparian woodrat would respond or adapt to a loss of sheltering habitat or how it would affect the woodrat's reproductivity, but the Service anticipates the effect to be low. Therefore, the PA is not expected to appreciably affect riparian woodrat reproduction, and we conclude that the effects would not significantly reduce the range-wide reproductive capacity of the species.

Numbers

The number of riparian woodrats in the Action Area is relatively low, based on recent and past records (Service 2020). The Service anticipates that the PA may result in effects to the riparian woodrat due to the continued degradation of riparian habitat; however, the number of riparian woodrats affected would be very low. This is especially true relative to the range-wide numbers. Therefore, the PA is not expected to reduce the number of riparian woodrats throughout the species' range.

Distribution

The Service anticipates the number of riparian woodrat likely to be affected by the PA will be very low. We do not expect that any riparian woodrat will be directly killed or harmed by any of the actions associated with the PA. We also conclude that riparian woodrat will continue to survive in the Action Area regardless of the activities. We do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of the riparian woodrat, the Environmental Baseline for the Action Area, the effects of the PA and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- The number of riparian woodrats likely to be affected by the PA will be very low, and take of the species is not reasonably certain to occur.

h. References

(Service) U.S. Fish and Wildlife Service. 1998. Recovery Plan for Upland Species of the San Joaquin Valley, California. Region 1, Portland, Oregon. 319 pp. https://ecos.fws.gov/docs/recovery_plan/980930a.pdf

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______. 2020. Riparian Woodrat (*Neotoma fuscipes riparia*) 5-year review. U.S. Fish and Wildlife Sacramento Fish and Wildlife Office. https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2988.pdf

14. Salt Marsh Harvest Mouse

a. Status of the Species

There are two subspecies of the salt marsh harvest mouse: the northern subspecies (R. r. *halicoetes*) and the southern subspecies (*R. r. raviventris*) both of which are listed as endangered. Information about the salt marsh harvest mouse biology and ecology is available in the *Recovery Plan for Tidal Marsh Ecosystems of Northern and Central California*, available at: https://ecos.fws.gov/docs/recovery_plan/TMRP/20130923_TMRP_Books_Signed_FINAL.pdf (Service 2013a). Threats evaluated during the drafting of the recovery plan and discussed in the final document have continued to act on the species since its publication, with loss of habitat being the most significant effect. For the most recent comprehensive assessment of the species' range-wide status, please refer to the salt marsh harvest mouse 5-year review at https://ecos.fws.gov/docs/tess/species_nonpublish/3630.pdf (Service 2021). No change in the species' listing status was recommended in this 5-year review.

b. Status of the Critical Habitat

Critical habitat has not been designated for this species.

c. Environmental Baseline

There are numerous documented CNDDB occurrences of salt marsh harvest mouse in the Suisun Marsh portion of the Action Area (CDFW 2024). This species has been observed in tidal wetlands and along sloughs as well as within managed wetlands. Salt marsh harvest mouse use of managed wetlands has been documented to be as high, or higher than, tidal wetland use (Sustaita *et al.* 2011). Wetlands in Suisun Marsh support patchy and unstable, but sometimes sizeable populations of salt marsh harvest mice with fairly high densities despite management activities occurring in the marsh (Service 2013a). Salt marsh harvest mice are also sometimes found in significant numbers in grasslands at the upper edge of diked marshes in the Suisun Bay (Zetterquist 1976; Shellhammer *et al.* 1988).

Perennial pepperweed (*Lepidium latifolium*) is an aggressive, non-native herbaceous weed displacing native vegetation in the Suisun Marsh and other locations throughout California. Pepperweed occurrence within the Action Area is high. Pepperweed can be problematic to control because of its underground rhizomes that are difficult to kill with broad-spectrum herbicides. Limited success has occurred in the Action Area to control and manage the overtaking of pepperweed long-term. Pepperweed poses a serious threat to many native ecosystems and can displace threatened and endangered species, like the salt marsh harvest mouse, or interfere with the regeneration of important plant species.

Downlisting criteria of the salt marsh harvest mouse include achieving, within the Suisun Bay Recovery Unit, conservation of 1,000 or more acres of muted or tidal marsh in the Western Suisun/Hill Slough Marsh Complex, 1,000 or more acres of muted or tidal marsh in the Suisun Slough/Cutoff Slough Marsh Complex, 1,500 or more acres of diked or tidal marsh in the Grizzly Island Marsh Complex, 1,000 or more acres of muted or tidal marsh in the Nurse Slough/Denverton Slough Marsh Complex, and 500 or more acres of muted or tidal marsh in the Contra Costa County Marsh Complex. Currently, 2,500 acres of suitable habitat throughout the Marsh have been conserved as salt marsh harvest mouse habitat. The salt marsh harvest mouse Conservation Areas are Peytonia Slough; Hill Slough West Ponds 1, 2, 4, and 4A; Hill Slough East Areas 8 and 9; a portion of Joice Island, Crescent Unit; a portion of Lower Joice Island, Blacklock; and Grizzly Island Ponds 1 and 15. Mitigation areas are Island Slough Ponds 4 and 7 (Service 2013b).

The Service has completed numerous consultations in the Suisun Marsh in the Action Area with a majority of the consultations being related to on-going maintenance activities or conversion of managed marsh to another use, such as tidal marsh restoration. The June 2013, *Biological Opinion on the Proposed Suisun Marsh Habitat Management, Preservation, and Restoration Plan and Project-Level Actions in Solano County, California* (08ESMF00-

2012-F-0602-2) was issued to the Corps to cover projects that fall under the Corps' Regional General Permit, their Letters of Permission, or individual permits in the Suisun Marsh. Example tidal marsh restoration projects that have been consulted on in the Action Area include Tule Red (08FBDT00-2016-F-0071), Blacklock (1-1-06-I-1880), and Montezuma Wetlands (1-1-99-F-12).

The conversion of managed wetlands to tidal marsh in Suisun Marsh has led to a decline in available habitat for salt marsh harvest mice. The Suisun Marsh 2021 triennial vegetation update suggests there are 46,661 acres of potential salt marsh harvest mouse habitat in Suisun Marsh, with approximately 81% of this habitat in leveed areas, and the remaining habitat in tidally influenced areas. The leveed areas have seen a 6.5% decrease in potential habitat since 2018, and an overall 9.2% decrease since 1999. The tidal areas of the Marsh have seen a 2.2% increase in potential habitat since 2018, with an overall 59.3% increase since 1999. Over the entire marsh, potential habitat has decreased by 5% since 2018 and 1% since 1999 (GIC 2024). This temporary loss was anticipated in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan and is being monitored by the Suisun Marsh Habitat Management, Preservation, and Restoration Plan Adaptative Management Plan Team. Future restoration projects in Suisun Marsh will continue to incorporate measures to protect existing salt marsh harvest mouse habitat.

d. Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

This element of the PA is addressed under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp. Depending on the nature, scope, location, and timing of restoration actions associated with individual restoration projects, there is a potential to adversely affect salt marsh harvest mice during implementation of construction, long-term management, adaptive management, or monitoring activities. The salt marsh harvest mouse inhabits suitable vegetation communities in tidal and managed wetlands in the Suisun Marsh. The PA may result in harm, injury, or death of salt marsh harvest mice through the loss and degradation of their habitat from flooding and through crushing by equipment and machinery. Salt marsh harvest mouse habitat may be destroyed or fragmented by levee breaching, levee creation, and other activities that involve the movement of the soil or other material. Individual salt marsh harvest mice may also be disturbed by noise and vibrations associated with levee breaching, levee creation, and construction activities within or adjacent to salt marsh habitat resulting in the disruption of feeding, sheltering, or breeding activities. Salt marsh harvest mice that are disturbed may be flushed from protective cover or their territories exposing the mice to predators. Disturbance to females from March to November may cause abandonment or failure of the current litter. Thus, displaced salt marsh harvest mice may suffer from increased predation, competition, mortality, and reduced reproductive success. The likelihood of disturbance of salt marsh harvest mice during construction activities increases if these activities occur during an extreme high tide event when the mice are likely to escape the adjacent flooded marsh to seek higher ground on the outboard levees. Salt marsh harvest mice are most vulnerable to disturbance and predation during extreme high tide events particularly if there is a lack of upland refugia cover.

Conversion of suitable habitat in managed wetlands to tidal wetlands would result in a temporary reduction in suitable habitat. As the restored area evolves into a functioning, vegetated tidal wetland, it is expected to provide permanent suitable and sustainable habitat for the salt marsh harvest mouse. Restoration activities likely would be located throughout the Suisun Marsh and would be implemented over a span of years, rather than concentrated in a small geographic area or time frame that would have a potentially greater effect on this species. It is expected that suitable adjacent areas would continue to provide habitat for salt marsh harvest mouse between breaching the levee and the establishment of a fully functioning tidal wetland. Temporary losses of suitable habitat would be compensated for by the creation of tidal wetlands and through the individual project restoration designs.

Construction activities related to tidal restoration actions could result in the introduction or spread of noxious weed species, which could displace native species, thereby changing the diversity of species or number of any species of plants. The non-native invasive, perennial pepperweed is common in Suisun Marsh. Perennial pepperweed establishes poor above-ground cover as it is leafless in the winter and provides little cover during high winter tides. Without suitable upland refugia cover, salt marsh harvest mice are vulnerable to predation during high tide events when the mice escape the flooded marsh to seek higher ground. Perennial pepperweed also interferes with the establishment of marsh gumplant, a tall native evergreen sub-shrub used by salt marsh harvest mice for high tide cover in the high marsh. Spreading rhizomatous and by seed, perennial pepperweed may also displace pickleweed and other native salt marsh vegetation essential to the salt marsh harvest mouse. The *Chipps Island Tidal Habitat Restoration Project* will implement conservation measures and the framework described in the *Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp*, to minimize the spread of nonnative plants as part of the restoration design and during project implementation. Additionally, proposed restoration sites will be managed to promote tidal wetland vegetation so when inundation occurs, there is minimal potential to support nonnative species.

These actions are addressed programmatically in this consultation, so further detail about expected adverse effects and benefits, and any incidental take, already has or will be addressed in subsequent consultation prior to implementation. This could include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp or through project-specific consultations with the U.S. Army Corps of Engineers.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. Salt marsh harvest mice are assumed to be present during the times of the year in which operations will be occurring in the Suisun Marsh. SMSCG reoperations are expected to temporarily lower marsh channel salinities but effects to mouse habitat are unknown. If it is determined that a proposed change in SMSCG operation is likely to adversely affect salt marsh harvest mice, reinitiation will occur.

Effects to Recovery

Continued threats from habitat loss due to filling, diking, subsidence, changes in water salinity, non-native species invasions, sea level rise associated with global climate change, and contamination are contributing factors to the decline of this species. Habitat suitability of many marshes is further limited by small size, fragmentation, and lack of other vital features such as sufficient refugial habitat. Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to salt marsh harvest mouse in order to gain long-term habitat benefits, thereby assisting in the recovery of this species if designed appropriately. Therefore, we conclude that the PA would not negatively affect, and may contribute to, recovery of the salt marsh harvest mouse.

e. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect salt marsh harvest mouse. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the salt marsh harvest mouse.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the salt marsh harvest mouse.

Reproduction

There is ample documentation of salt marsh harvest mice in tidal wetlands and along sloughs as well as within managed wetlands. As the Chipps Island Tidal Habitat Restoration Project is the last remaining restoration action to tier from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp it will be consistent with the conservation measures identified in that BiOp which include preconstruction surveys and exclusion fencing. Therefore, the PA is not expected to negatively affect salt marsh harvest mouse reproduction range-wide, and we conclude that the effects would not reduce the range- wide reproductive capacity of the species.

Numbers

Patchy and unstable, though sometimes sizable populations of salt marsh harvest mouse occupy tidal marshes of Suisun Marsh. In the diked marshes areas of Suisun Marsh, there are relatively stable populations of fairly high densities (Service 2013a). With implementation of the PA, low mortality or injury of individuals are expected to occur from tidal marsh restoration in the Suisun Marsh area if conservation measures are implemented fully and properly. Restoration actions, if designed appropriately, would contribute to the recovery of salt marsh harvest mice by creating more sustainable habitat for salt marsh harvest mice. Therefore, the PA is not expected to reduce the range-wide numbers of salt marsh harvest mice.

Distribution

We do not anticipate that the range-wide distribution of the salt marsh harvest will be reduced because effects to the species from restoration construction activities. If designed appropriately, as restored areas evolve into functioning, vegetated tidal wetland, they are expected to provide benefits by adding permanent suitable and sustainable habitat for the salt marsh harvest mouse. Therefore, we do not expect Reclamation's actions will reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of the salt marsh harvest mouse, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- The number of salt marsh harvest mice likely to be affected by the PA will be low relative to the number of salt marsh harvest mice range-wide.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the salt marsh harvest mouse long-term.

h. References

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15. Soft Bird's-Beak

a. Status of the Species

Soft bird's-beak (*Chloropyron molle* ssp. *molle*) was listed as endangered throughout its entire range on November 20, 1997 (Service 1997). Information about the soft bird's-beak's biology and ecology is available in the *Recovery Plan for the Tidal Marsh Ecosystems of Northern and Central California* (Service 2013). For the most recent comprehensive assessment of the species' range-wide status, please refer to the Soft Bird's-Beak 5-year Review, available at: https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/8889.pdf (Service 2023). The Service's January 2023 five-year review for the soft bird's-beak recommended the soft bird's-beak remain listed as endangered due to the continuation of threats from muting (damping) of tides and salinity, invasive non-native plants, seed predation, sea level rise predicted to result from global climate change, mosquito abatement, oil spills, and (for these small populations) random events (Service 2023).

b. Status of the Critical Habitat

The Service designated critical habitat for soft bird's-beak on April 12, 2007 (Service 2007). The PCEs defined for soft bird's-beak were derived from its biological needs. Based on the life history, biology, and ecology of the species, and the habitat requirements for sustaining the essential life-history functions of the species, the Service determined that the PCEs essential to the conservation of the soft bird's-beak are:

1. Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

2. Rarity or absence of plants that naturally die in late spring (winter annuals); and

3. Partially open spring canopy cover (approximately 790 nMol/m2/s) at ground level, with many small openings to facilitate seedling germination.

Five units have been designated as critical habitat for soft bird's-beak in Contra Costa, Napa, and Solano Counties, California. Contra Costa, Napa, and Solano Counties have approximately 22 acres, 384 acres, and 1,870 aces of critical habitat, respectively. Common threats that may require special management considerations or protections of the PCEs for soft bird's-beak in all five units include: (1) mosquito abatement activities (ditching, dredging, and chemical spray operations), which may damage the plants directly by trampling and soil disturbance, and indirectly by altering hydrologic processes and by providing relatively dry ground for additional foot and vehicular traffic; (2) general foot and off-road vehicle traffic through soft bird's beak populations that could result in their damage and loss in impacted areas; (3) increases in the proliferation of nonnative invasive plants from human-induced soil disturbances leading to the invasives outcompeting soft bird's beak; (4) control or removal of nonnative invasive plants, especially *Lepidium latifolium,* which, if not carefully managed, can damage soft bird's beak populations through the injudicious application of herbicides, by direct trampling, or through the accidental transport of invasive plant seeds to new areas; and (5) presence of *Lipographis* *fenestrella* (a moth) larvae that could reduce the reproductive potential of soft bird's beak through flower, fruit, and seed predation.

c. Environmental Baseline

Soft bird's-beak was thought to be limited to three general locations in the Suisun Marsh portion of the Action Area: Rush Ranch, CDFW's Joice Island Unit of the Grizzly Island Wildlife Management Area, and the Hill Slough marsh (DWR 2001); however, this species also occurs on Luco Slough and east of Bradmoor Island (CDFW 2024). The Hill Slough population accounts for more than 80% of the occurrences of this species in the Action Area (Service 2013).

The Service has completed numerous consultations in the Suisun Marsh in the Action Area with a majority of the consultations being related to on-going maintenance activities or conversion of managed marsh to another use, such as tidal marsh restoration. The Service issued the June 2013, *Biological Opinion on the Proposed Suisun Marsh Habitat Management, Preservation, and Restoration Plan and Project-Level Actions in Solano County, California* (08ESMF00-2012-F-0602-2) to the Corps to cover projects that fall under the Corps' Regional General Permit, their Letters of Permission, or individual permits in the Suisun Marsh. Example tidal marsh restoration projects that have been consulted on in the Action Area include Tule Red (08FBDT00-2016-F-0071), Blacklock (1-1-06-I-1880), and Montezuma Wetlands (1-1-99-F-12).

d. Environmental Baseline of the Critical Habitat

Three critical habitat units identified for soft bird's-beak occur in the Action Area. These units are Unit 2, Hill Slough Wildlife Management Area; Unit 4, Rush Ranch/Grizzly Island Wildlife Management Area; and Unit 5, Southampton Marsh. Soft bird's-beak occurs in each of these Units.

e. Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

This element of the PA is addressed under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp. Soft bird's-beak is known to occur in the Action Area. Construction activities associated with tidal wetland restoration could affect these plant populations. Soft bird's-beak may be directly or indirectly affected by a restoration project; however, adequate buffer areas would be established to exclude activities that would directly remove or alter the habitat of an identified population or result in indirect adverse effects on the species' habitat as articulated in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp . However, indirect effects related to restoration, such as scour adjacent to the breach location, could result in a loss of suitable habitat for soft bird's beak. Breach size and location would be selected to minimize the effects of scour on soft bird's-beak. Additionally, restoration of tidal marshes is expected to create a range of marsh elevation habitat that would support soft bird's beak. Long term effects of large-scale tidal marsh restoration will result in increased habitat for these rare plants.

Construction activities related to tidal restoration actions could result in the introduction or spread of noxious weed species, which could displace native species, thereby changing the diversity of species or number of any species of plants. Soil-disturbing activities during construction could promote the introduction of plant species that currently are not found in the Action Area, including exotic pest plant species. Construction activities also could spread exotic pest plants that already occur in the Action Area. The Chipps Island Tidal Habitat Restoration Project will be managed to promote tidal wetland vegetation per the framework and conservation measures in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp so when inundation occurs, there is minimal potential to support nonnative species.

Tidal wetland restoration will occur by breaching and/or lowering exterior levees to restore tidal inundation to restoration sites. Breach locations will be chosen to minimize temporary upstream tidal muting as described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Restoration projects have been spread throughout the Suisun Marsh and implemented over several years. Interval implementation and the effect of sea level rise have minimized the potential for substantial tidal muting. Although tidal muting could result in a temporary reduction in the tidal water surface elevation range, the overall acreage of tidal wetlands in the Suisun Marsh would increase substantially because of restoration actions and provide for more suitable habitat for the soft bird's-beak.

These actions are addressed programmatically in this consultation, so further detail about expected adverse effects and benefits have already been or will be addressed in subsequent consultation prior to implementation. As the Chipps Island Tidal Habitat Restoration Project is the last remaining proposed restoration project, this framework would include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and implementing the Conservation Measures outlined in that BiOp.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

Operations of the SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. SMSCG operations are expected to lower marsh salinities creating a potential vegetation shift in Suisun Marsh. Changes in tidal stage, flow, or erosion were not analyzed in this BA and therefore effects are uncertain at this time. If through planning and implementation of the project-level activities, adverse effects to the soft bird's-beak are realized and were not analyzed herein, reinitiation will occur.

Effects to Recovery

Continued threats from muting (damping) of tides and salinity, invasive non-native plants, seed predation, sea level rise predicted to result from global climate change, mosquito abatement, oil spills, and (for these small populations) random events are contributing factors to the decline of soft bird's-beak (Service 2013). Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to the soft bird's-beak in order to increase long-term habitat benefits, thereby assisting in the recovery of this species. Therefore, we conclude that the PA would not negatively affect, and may contribute to, recovery of the soft bird's-beak.

f. Effects of the Action on Critical Habitat

Effects of the Proposed Action on Soft Bird's-Beak Critical Habitat

Tidal Habitat Restoration in Suisun Marsh

Within Suisun Marsh there are 1,870 acres of critical habitat designated for soft bird's-beak in Units 2, 4, and 5. Indirect effects related to restoration, such as scour adjacent to the breach location, could result in a loss of critical habitat. Breach size and location would be selected to minimize the effects of scour on special-status species habitat as articulated in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Creation of tidal marsh may create additional habitat within critical habitat units for these species. PCEs will remain intact, contributing to the high conservation value of the unit as a whole, and sustaining the unit's role in the conservation and recovery of the soft bird's-beak.

These actions are addressed programmatically in this consultation, so further detail about expected effects and benefits have already been or will be addressed in subsequent consultation prior to implementation. As the Chipps Island Tidal Habitat Restoration Project is the last remaining proposed restoration project, this framework would include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and implementing the Conservation Measures outlined in that BiOp.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. SMSCG reoperations are expected to lower marsh salinities creating a potential shift vegetation in Suisun Marsh. Changes in tidal stage, flow, or erosion were not analyzed in this BA and therefore effects are uncertain at this time.

g. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect soft bird's-beak. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the soft bird's-beak.

h. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the soft bird's-beak.

Reproduction

Soft bird's-beak is an annual plant but will regenerate from a persistent dormant seed bank. The longevity of the seed bank is unknown; however, some colonies have failed to emerge for several years and then reappeared. Factors, such as predation, disease, and wind dispersal, can influence the seed production and impact plant species success (Service 2013). The Chipps Island Tidal Habitat Restoration Project will tier from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and will implement the conservation measures identified in that BiOp which will avoid or minimize those effects and provide long-term benefits to the soft bird's-beak. Therefore, we conclude that the effects would not reduce the range-wide reproductive capacity for the species.

Numbers

Limited documented locations of soft bird's-beak exist in the Suisun Marsh. With implementation of the PA, a low amount of direct mortality or injury of individual plants and colonies are expected to occur from tidal marsh restoration in the Suisun Marsh area. Restoration actions would contribute to the recovery of soft bird's-beak by creating more sustainable habitat for these species and may result in increased numbers.

Distribution

We do not anticipate that the range-wide distribution of the soft bird's-beak will be reduced because the PA may have short-term adverse effects but is expected to have long-term benefits. Although the Action Area overlaps the entire range of soft bird's-beak, the PA is not expected to reduce the distribution. The effect to these species from restoration construction activities will be minimized by the implementation of the conservation measures and framework from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Therefore, we do not expect Reclamation's actions will reduce the species' distribution of soft bird's-beak.

i. Conclusion

Soft Bird's-Beak

After reviewing the current status of the soft bird's-beak, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of this species. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- A low number of individuals are likely to be affected by the PA and restored wetlands may result in increased numbers of the species.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the soft bird's-beak.

Soft Bird's-Beak Critical Habitat

After reviewing the current status of the soft bird's-beak critical habitat, Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to destroy or adversely modify soft bird's-beak critical habitat. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- Creation of tidal marsh may create additional habitat within critical habitat units for these species.

- PCEs will remain intact, contributing to the high conservation value of each critical habitat unit and each critical habitat as a whole, and sustaining each unit's role in the conservation and recovery of the soft bird's-beak.

j. References

(CDFW) California Department of Fish and Wildlife (CDFW). 2024. California Natural Diversity Database. RareFind version 5. Natural Heritage Division. Sacramento, California. Available at: https://map.dfg.ca.gov/bios/

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16.Suisun Thistle

a. Status of the Species

Suisun thistle (*Cirsium hydrophilum* var. *hydrophilum*) was listed as endangered in its entire range on November 20, 1997 (Service 1997). Information about the Suisun thistle's biology and ecology is available in *Recovery Plan for the Tidal Marsh Ecosystems of Northern and Central California* (Service 2013). For the most recent comprehensive assessment of the species' range-wide status, please refer to the Suisun Thistle 5-year Review, available at: https://ecosphere-documents-production-public.s3.amazonaws.com/sams/public_docs/species_nonpublish/3554.pdf (Service 2021). The Service's September 2021 five-year review for Suisun thistle recommended the Suisun thistle remain listed as endangered due to the continuation of threats from muting (damping) of tides and salinity, invasive non-native plants, seed predation, sea level rise predicted to result from global climate change, mosquito abatement, oil spills, and (for these small populations) random events (Service 2021).

b. Status of the Critical Habitat

The Service designated critical habitat for Suisun thistle on April 12, 2007 (Service 2007). The PCEs defined for Suisun thistle were derived from its biological needs. Based on the life history, biology, and ecology of the species, and the habitat requirements for sustaining the essential life-history functions of the species, the Service determined that the PCEs essential to the conservation of the Suisun thistle are:

1. Persistent emergent, intertidal, estuarine wetland at or above the mean high-water line (as extended directly across any intersecting channels);

2. Open channels that periodically contain moving water with ocean derived salts in excess of 0.5 %; and

3. Gaps in surrounding vegetation to allow for seed germination and growth.

The three units designated as critical habitat for Suisun thistle comprise 2,052 acres of Solano County. Common threats that may require special management considerations or protections of the PCEs for Suisun thistle in all three units include: (1) alterations to channel water salinity and tidal regimes from the operation of the SMSCGs that could affect the depth, duration, and frequency of tidal events and the degree of salinity in the channel water column; (2) mosquito abatement activities (dredging, and chemical spray operations), which may damage the plants directly by trampling and soil disturbance, and indirectly by altering hydrologic processes and by providing relatively dry ground for additional foot and vehicular traffic; (3) rooting, wallowing, trampling, and grazing impacts from livestock and feral pigs that could result in damage or loss to C. *hydrophilum* var. *hydrophilum* colonies, or in soil disturbance and compaction, leading to a disruption in natural marsh ecosystem processes; (4) the proliferation of nonnative invasive plants, especially *Lepidium latifolium*, leading to the invasives outcompeting C. *hydrophilum* var. *hydrophilum*; and (5) programs for the control or removal of non-native invasive plants, which, if not conducted carefully, can damage C. *hydrophilum* var. *hydrophilum* populations through the injudicious application of herbicides, by direct trampling, or through the accidental transport of invasive plant seeds to new areas. An additional threat that may require special management considerations or protection of the PCEs in Units 1 and 2 includes urban or residential encroachment from Suisun City to the north that could increase stormwater and wastewater runoff into these Units.

c. Environmental Baseline

This species is known to exist only in Suisun Marsh and typically is found in the Action Area in the middle to high marsh zone along tidal channels and in irregularly flooded estuarine wetlands (DWR 2001). Three populations of Suisun thistle are known (DWR 2001), and there are four occurrences in the Action Area (CDFW 2024). One population occurs on CDFW's Peytonia Slough Ecological Reserve. The second population and the remaining occurrences are associated with the Cutoff Slough tidal marshes and CDFW's Joice Island Unit of the Grizzly Island Wildlife Management Area.

The Service has completed numerous consultations in the Suisun Marsh in the Action Area with a majority of the consultations being related to on-going maintenance activities or conversion of managed marsh to another use, such as tidal marsh restoration. The Service issued the June 2013, *Biological Opinion on the Proposed Suisun Marsh Habitat Management, Preservation, and Restoration Plan and Project-Level Actions in Solano County, California* (08ESMF00-2012-F-0602-2) to the Corps to cover projects that fall under the Corps' Regional General Permit, their Letters of Permission, or individual permits in the Suisun Marsh. Example tidal marsh restoration projects that have been consulted on in the Action Area include Tule Red (08FBDT00-2016-F-0071), Blacklock (1-1-06-I-1880), and Montezuma Wetlands (1-1-99-F-12).

d. Environmental Baseline of the Critical Habitat

Three critical habitat units have been identified for Suisun thistle in the Action Area. These units are Unit 1, Hill Slough Wildlife Management Area; Unit 2, Peytonia Slough Ecological Reserve; and Unit 3, Rush Ranch/Grizzly Island Wildlife Management Area. Suisun thistle occurs in each of these Units.

e. Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

This element of the PA is addressed under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp. Suisun thistle are known to occur in the Action Area. Construction activities associated with tidal wetland restoration could affect these plant populations. Suisun thistle may be directly or indirectly affected by a restoration project; however, adequate buffer areas would be established to exclude activities that would directly remove or alter the habitat of an identified population or result in indirect adverse effects on the species' habitat as articulated in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. However, indirect effects related to restoration, such as scour adjacent to the breach location, could result in a loss of suitable habitat for Suisun thistle. Breach size and location would be selected to minimize the effects of scour on Suisun thistle habitat. Additionally, restoration of tidal marshes is expected to create a range of marsh elevation habitat that would support Suisun thistle. Long term effects of large-scale tidal marsh restoration will result in increased habitat for these rare plants.

Construction activities related to tidal restoration actions could result in the introduction or spread of noxious weed species, which could displace native species, thereby changing the diversity of species or number of any species of plants. Soil-disturbing activities during construction could promote the introduction of plant species that currently are not found in the Action Area, including exotic pest plant species. Construction activities also could spread exotic pest plants that already occur in the Action Area. The Chipps Island Tidal Habitat Restoration Project will be managed to promote tidal wetland vegetation per the framework and conservation measures in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp so when inundation occurs, there is minimal potential to support nonnative species.

Tidal wetland restoration will occur by breaching and/or lowering exterior levees to restore tidal inundation to restoration sites. Breach locations will be chosen to minimize temporary upstream tidal muting. as described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Restoration projects have been spread throughout the Suisun Marsh and implemented over several years. Interval implementation and the effect of sea level rise have minimized the potential for substantial tidal muting. Although tidal muting could result in a temporary reduction in the tidal water surface elevation range, the overall acreage of tidal wetlands in the Suisun Marsh would increase substantially because of restoration actions and provide for more suitable habitat for the Suisun thistle.

These actions are addressed programmatically in this consultation, so further detail about expected adverse effects and benefits will be addressed in subsequent consultation prior to implementation. This could include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp or project-specific consultations with the Corps.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. SMSCG reoperations are expected to lower marsh salinities creating a potential vegetation shift in Suisun Marsh. Changes in tidal stage, flow, or erosion were not analyzed in this BA and therefore effects are uncertain at this time. If through planning and implementation of the project-level activities, adverse effects to the Suisun thistle are realized and were not analyzed herein, reinitiation will occur.

Effects to Recovery

Continued threats from muting (damping) of tides and salinity, invasive non-native plants, seed predation, sea level rise predicted to result from global climate change, mosquito abatement, oil spills, and (for these small populations) random events are contributing factors to the decline of Suisun thistle (Service 2013). Habitat loss is the primary cause of decline of the Suisun thistle (Service 2013). Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to the Suisun thistle in order to increase long-term habitat benefits, thereby assisting in the recovery of this species. Therefore, we conclude that the PA would not negatively affect, and may contribute to, recovery of the Suisun thistle.

f. Effects of the Action on Critical Habitat

Tidal Habitat Restoration in Suisun Marsh

This element of the PA is addressed under the framework programmatic approach as described in the *Consultation Approach* section of this Within Suisun Marsh there are 2,052 acres of critical habitat designated for Suisun thistle in Units 1, 2, and 3. Indirect effects related to restoration, such as scour adjacent to the breach location, could result in a loss of critical habitat. Breach size and location would be selected to minimize the effects of scour on special-status species habitat as articulated in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Creation of tidal marsh may create additional habitat within critical habitat units for these species. PCEs will remain intact, contributing to the high conservation value of the unit as a whole, and sustaining the unit's role in the conservation and recovery of Suisun thistle.

These actions are addressed programmatically in this consultation, so further detail about expected effects and benefits will be addressed in subsequent consultation prior to implementation. As the Chipps Island Tidal Habitat Restoration Project is the last remaining proposed restoration project, this framework would include tiering or appending to the existing Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and implementing the Conservation Measures outlined in that BiOp.

Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

The SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. SMSCG reoperations are expected to lower marsh salinities creating a potential shift vegetation in Suisun Marsh. Changes in tidal stage, flow, or erosion were not analyzed in this BA and therefore effects to Suisun thistle critical habitat are uncertain at this time. If through planning and implementation of the project-level activities, adverse effects to the Suisun thistle are realized and were not analyzed herein, reinitiation will occur.

g. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect Suisun thistle. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for Suisun thistle.

h. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on Suisun thistle.

Reproduction

Suisun thistle is an annual plant, dying after one year of seed reproduction (Service 2013). The reproductive output of individual plants and colonies of Suisun thistle has not been quantified. No quantitative data are available on seed set, seed abortion, or seed predation.

Individual branched plants may produce hundreds of seedheads. Factors, such as predation, disease, and wind dispersal, can influence the seed production and impact plant species success (Service 2013). The Chipps Island Tidal Habitat Restoration Project will tier from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp and will be consistent with the conservation measures identified in that BiOp will avoid or minimize those effects and provide long-term benefits to the soft bird's-beak and Suisun thistle. Therefore, the PA is not expected to negatively affect the Suisun thistle reproduction range-wide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

Limited documented locations of Suisun thistle exist in the Suisun Marsh. With implementation of the PA, a low amount of direct mortality or injury of individual plants and colonies are expected to occur from tidal marsh restoration in the Suisun Marsh area. Restoration actions would contribute to the recovery of Suisun thistle by creating more sustainable habitat for the species and may result in increased numbers of plants.

Distribution

We do not anticipate that the range-wide distribution of the Suisun thistle will be reduced because the PA may have short-term adverse effects but is expected to have long-term benefits. Although the Action Area overlaps the entire Suisun thistle's range, the PA is not expected to reduce the distribution. The effect to this species from restoration construction activities will be minimized by the implementation of the conservation measures and framework from the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp. Therefore, we do not expect Reclamation's actions will reduce the species' distribution of Suisun thistle.

i. Conclusion

Suisun Thistle

After reviewing the current status of the Suisun thistle, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of this species. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- The low number of individuals likely to be affected by the PA will not appreciably reduce the likelihood of Suisun thistle survival and recovery and restored wetlands may result in increased numbers of both plants species.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the Suisun thistle long-term.

Suisun Thistle Critical Habitat

After reviewing the current status of the Suisun thistle critical habitat, Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to destroy or adversely modify Suisun thistle critical habitat. We have reached this conclusion because:

- Tidal restoration will follow the framework and conservation measures described in the Suisun Marsh Habitat Management, Preservation, and Restoration Plan BiOp.

- Creation of tidal marsh may create additional habitat within critical habitat units for this species.

- PCEs will remain intact, contributing to the high conservation value of each critical habitat unit and each critical habitat as a whole, and sustaining each unit's role in the conservation and recovery of Suisun thistle.

j. References

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17. Western Snowy Plover

a. Status of the Species

The western snowy plover is a small pale shorebird that nests on beaches and salt pannes in western North America. The Service listed the Pacific Coast population of the snowy plover (i.e., "western snowy plover") as a threatened species in 1993 because of a decline in the breeding population, loss of breeding habitat, and increased depredation by non-native predators. Information about the western snowy plover biology and ecology is available in the *Recovery Plan for the Pacific Coast Population of the Western Snowy Plover (Charadrius alexandrinus nivosus)*, available at https://ecos.fws.gov/docs/recovery_plan/070924_2.pdf (Service 2007). For the most recent comprehensive assessment of the species' range-wide status, please refer to the western snowy plover 5-year review, available at https://ecos.fws.gov/docs/tess/species_nonpublish/2806.pdf (Service 2019). No change in the species' listing status was recommended in this 5-year review. Threats evaluated during that review and discussed in the final document have continued to act on the species with loss of habitat and degradation being the most significant effect.

b. Status of the Critical Habitat

The Service designated critical habitat for the snowy plover in 2005 and revised the critical habitat designation in 2012. All critical habitat is designated outside of the Action Area.

c. Environmental Baseline

Although most sightings of western snowy plovers are concentrated around the San Francisco Bay, western snowy plover nesting has been observed on the east side of Suisun Marsh at the Montezuma Wetlands Project almost annually since 2005. Since 2005, the San Francisco Bay Recovery Unit, Unit 3, experienced a decline in population in 2006, 2008, 2011, 2012, 2014, and 2015; although, between 2005-2018 overall the population has increased from 124 breeding adults to 235 adults despite these fluctuations (Service 2019).

However, the population remains under the 500-bird recovery threshold and faces ongoing threats of nest predation and depredation by domesticated species, competition and aggression between plovers due to limitations of the species' altered habitat, conflicting habitat management priorities with those of other listed species, and variations in nesting habitat availability (Service 2019).

During the 2023 breeding season, 368 adults were recorded in the San Francisco Bay estuary (Recovery Unit 3 [RU3]) through combined survey efforts of the San Francisco Bay Bird Observatory (SFBBO), the Service, CDFW, and other stakeholders. Of the 304 nests monitored by SFBBO, 64% hatched, 31% were depredated, 2% were flooded, 1% fell to miscellaneous other fates, and 2% were unknown. An additional 39 nests were detected at the brood stage. Other members of the RU3 working group documented a total of 23 nests. Among these 23 nests, 43% hatched, 35% were depredated, 13% fell to miscellaneous other fates, and 9% were unknown. An additional eight nests were documented at the brood stage (SFBBO 2024). See Table 17-1 for additional western snowy plover survey information.

Table 17-1: Montezuma Wetlands - Western Snowy Plover Data 2015-2023

Year	# of surveys	range of survey dates	number of nests observed	range of SNPL adults observed	range of SNPL chicks observed	estimated number of successful fledglings
2023	22	03/13/2023 - 08/29/2023	1	1-24	1-3	unknown
2022		05/2022 - 07/2022	5	2-8	13	9
2021		04/2021 - 07/2021	3	2-14	8	5-6
2020		03/2020 - 07/2020	4	4	5	unknown
2019		01/2019-	2	1-4	3	unknown

		09/2019				
2018	5	06/2018 - 07/2018	0	2	0	unknown
2017	5	05/09/2017 - 08/30/2017	0	1-11	0	unknown
2016	19	05/16/2016 - 08/02/2016	1	1-3	1 (3 eggs total, 2 unhatched)	1
2015	4		1*	0	0, nest lost before hatching	unknown

*note: nest found, then lost before the beginning of a monitoring period

(Pers. Comm Cassie Pinnell 2024)

At Montezuma Wetlands in 2023, Vollmar Natural Lands Consulting biologists documented three nests with at least one hatching and at least one failing. They detected an additional four nests at the brood stage (SFBBO 2024).

The Service has formally consulted on two projects within the Action Area that may affect the plover: the Bay Area Mosquito Source Reduction Project in Alameda, Contra Costa, Marin, Napa, San Mateo, Santa Clara, Solano, and Sonoma Counties (File No. 2022-0048737), and the Montezuma Wetlands Project in Solano County (File No. 2022-0074267).

d. Effects of the Action

Tidal Habitat Restoration in Suisun Marsh

This element of the PA is addressed under the framework programmatic approach as described in the *Consultation Approach* section of this BiOp. Consultation on construction of the last remaining restoration project, Chipps Island, has been initiated and has been determined not to affect western snowy plover. Therefore, the tidal habitat restoration framework does not apply to this species since no effects are anticipated. Suisun Marsh Salinity Control Gates (Proposed Flow Changes)

Operations of the SMSCGs are being proposed to direct more fresh water in the Suisun Marsh to improve habitat conditions for delta smelt in the region. Depending on the timing of the proposed operations, SMSCG operations may overlap with the western snowy plover late breeding season and potential presence in the Suisun Marsh to forage. Western snowy plovers forage on invertebrates in the wet sand and amongst surf-cast kelp within the intertidal zone, in dry sand areas above the high tide, on salt pannes, on spoil sites, and along the edges of salt marshes, salt ponds, and lagoons (Service 2007). SMSCG operations are expected to temporarily lower marsh salinities creating a potential shift in their prey base availability in Suisun Marsh. However, foraging is readily available in the Suisun Marsh and the restoration and enhancement projects are expected to increase food quality of habitat available to the western snowy plover. Adverse effects to western snowy plovers are not expected to occur. If through planning and implementation of the project-level activities, adverse effects to the western snowy plover are realized and were not analyzed herein, reinitiation will occur.

Effects to Recovery

Implementation of restoration actions in the Suisun Marsh may result in short-term adverse effects to western snowy plovers in order to gain an increase in long-term habitat benefits, thereby assisting in the recovery of this species. Therefore, we conclude that the PA would not negatively affect, and may contribute to, recovery of the western snowy plover.

e. Cumulative Effects

The activities described in Section 8-e for delta smelt are also likely to affect western snowy plovers. These include agricultural practices, recreation, urbanization and industrialism, and greenhouse gas emissions. Therefore, the effects described in Section 8-e are incorporated by reference into this analysis for the western snowy plover.

f. Summary of Aggregated Effects

In determining whether a proposed action is likely to jeopardize the continued existence of a species, we consider the effects of the action with respect to reproduction, numbers, and distribution of the species. We also consider the effects of the action on the recovery of the species. In that context, the following paragraphs summarize the effects of the PA on the western snowy plover.

Reproduction

Western snowy plovers are known to breed and nest at one location in the Suisun Marsh. The PA is not expected to negatively affect western snowy plovers reproduction rangewide, and we conclude that the effects would not reduce the range-wide reproductive capacity of the species.

Numbers

With implementation of the PA, no mortality or injury of individuals are expected to occur from tidal marsh restoration. Restoration actions would contribute to the recovery of western snowy plover by creating more foraging habitat for western snowy plovers. Therefore, the PA is not expected to reduce the number of western snowy plovers.

Distribution

The number of western snowy plovers in the Suisun Marsh are relatively low in relation to the species' population numbers range wide. Although there is the potential to disturb individuals in a way that may result in altered normal behavior, it is still expected that these activities will not cause substantial disturbance to western snowy plovers. Western snowy plovers are highly mobile birds with the ability to forage in a variety of habitats throughout the Suisun Marsh. Therefore, we do not expect the PA to reduce the species' distribution relative to its range-wide condition.

g. Conclusion

After reviewing the current status of western snowy plover, the Environmental Baseline for the Action Area, the effects of the PA, and the cumulative effects, it is the Service's biological opinion that the PA is not likely to jeopardize the continued existence of the species. We have reached this conclusion because:

- The number of western snowy plovers likely to be affected by the PA will be low relative to the number of western snowy plovers range wide.

- The PA is being implemented in a manner that will restore and create more suitable, sustainable habitat for the western snowy plovers long-term.

h. References

(Service) U.S. Fish and Wildlife Service. 2007. Recovery Plan for the Pacific Coast population of the Western Snowy Plover (*Charadrius alexandrinus nivosus*) Volume 1: Recovery Plan. August 13, 2007. Issued by the California/Nevada Operations Office, Sacramento, CA. Accessible at: https://ecos.fws.gov/docs/recovery_plan/070924_2.pdf

_____. 2019. 5-year Review Western Snowy Plover [Pacific Coast population Distinct Population Segment] (*Charadrius nivosus nivosus*) 2019. September 10, 2019, Issued by the Arcata Fish and Wildlife Office, Arcata, CA. Accessible at: https://ecosphere-documents-production public.s3.amazonaws.com/sams/public_docs/species_nonpublish/2806.pdf

San Francisco Bay Bird Observatory (SFBBO). 2024. Western Snowy Plover and California Least Tern Monitoring in the San Francisco Bay Annual Report 2023. January 24, 2024. Accessible at: https://www.sfbbo.org/uploads/1/1/6/7/116792187/wspl_and_clte_monitoring_in_the_sf_bay_annual_report_2023_final__01-24-24_.pdf

Personal Communication

Email from Cassie Pinnell (Vollmar Natural Lands Consulting) to Andrew Raabe (Service). May 7, 2024.

18. Incidental Take Statement

Section 9 of the Act and Federal regulation pursuant to section 4(d) of the Act prohibit the take of endangered and threatened species, respectively, without special exemption. Take is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. Harm in the definition of "take" in the Act means an act which actually kills or injures wildlife. Such [an] act may include significant habitat modification or degradation where it actually kills or injures wildlife by significantly impairing essential behavioral patterns, including breeding, feeding, or sheltering (50 CFR 17.3). Under the terms of section 7(b)(4) and section 7(o)(2), taking that is incidental to and not the purpose of the agency action is not considered to be prohibited taking under the Act provided that such taking is in compliance with the terms and conditions of an incidental take statement.

The measures described in the Reasonable and Prudent Measures and Terms and Conditions are non-discretionary and must be undertaken by Reclamation so that they become binding conditions of any grant or permit issued to the applicant, as appropriate, for the exemption in section 7(o)(2) to apply. Reclamation has a continuing duty to regulate the activity covered by this incidental take statement. If Reclamation (1) fails to assume and implement the terms and conditions or (2) fails to require the applicant to adhere to the terms and conditions of the incidental take statement through enforceable terms that are added to the permit or grant document, the protective coverage of section 7(o)(2) may lapse. In order to monitor the impact of incidental take, Reclamation and DWR must report the progress of the action and its impact on the species to the Service as specified in the incidental take statement [50 CFR §402.14(i)(4)].

The Service has determined that the PA presents a mixed programmatic action, as described in the *Consultation Approach* section of this BiOp and defined in 50 CFR 402.02 (i.e., the proposed action includes elements that will not be subject to further section 7 consultation and elements that will be subject to future consultation). Therefore, consistent with our regulations at 50 CFR 402.14(i)(7), this ITS only covers those standard and stand-alone programmatic consultation elements of the PA for which incidental take is reasonably certain to occur.

The prohibitions against taking the northwestern pond turtle found in section 9 of the Act do not apply until the species is listed. However, the Service advises Reclamation and DWR to consider implementing the following Reasonable and Prudent Measures. If this conference opinion is adopted as a biological opinion following a listing, the Reasonable and Prudent Measures, with their implementing Terms and Conditions, will be non-discretionary.

a. Amount or Extent of Take

Surrogate Approach

In accordance with 50 CFR 402.14(i)(1)(i), a surrogate may be used to express the amount or extent of anticipated incidental take if the BiOp or ITS describes the causal link between the surrogate and anticipated take, explains why it is not practical to express the amount or extent of anticipated take or to monitor take-related impacts in terms of individuals, and sets a clear standard for determining when the level of anticipated take has been exceeded.

Surrogates are used for this ITS because, as described throughout this BiOp, it is impossible to accurately quantify and monitor the amount or number of individuals that are expected to be incidentally taken as a result of the PA. Large fractions of the incidental take of delta smelt and longfin smelt are not detected, for instance when individuals are eaten by predators in route to the Skinner and Tracy fish facilities, or when they die from predation or other food web-related mechanisms in the low-salinity zone when the projects change Delta outflow. Therefore, using detection in monitoring programs like fish salvage or IEP trawl surveys to quantify the specific anticipated level of incidental take is not a reliable measure. Other relevant factors include the variability associated with the effects of the PA, the relatively low population size of these species, difficulty in detecting individuals entrained or impinged (of delta smelt and longfin smelt), annual variations in the timing of various parts of the species' life cycles, sheer amount and dispersed nature of the habitat (for croplands utilized by giant garter snake), and variation in how individual animals utilize habitat within the Action Area.

Therefore, the Service is using the ecological conditions associated with take described below as the incidental take surrogates for individual delta smelt, longfin smelt, and giant garter snake.

In the BiOp, the Service has determined that incidental take is reasonably certain to occur as follows:

Delta Smelt and Longfin Smelt

The Service anticipates that the PA will result in the incidental take of individual delta smelt and longfin smelt due to hydrodynamic changes caused by the operation of the CVP and SWP. This includes effects from Delta outflow, the Banks and Jones pumping plants, the Skinner and Tracy fish facilities, and other CVP or SWP water diversion and water distribution systems in the Delta and Suisun Marsh. Regarding the CVP and SWP export of water from the Delta, the Service anticipates take in the form of kill or harm of all delta smelt and longfin smelt within the South Delta affected by water operations and other areas of the Delta where habitat quality is affected by Delta outflow.

Incidental take associated with this action is expected in the following forms: mortality and harm of delta smelt and longfin smelt adults, juveniles, and larvae. It is difficult to determine the number of individuals that could be injured or killed (including harm as a result of significant habitat modification) because free-swimming aquatic animals are difficult to observe in large water bodies and because delta smelt and longfin smelt are relatively rare. The methods used to track these species' status and trends can do so but have considerable statistical uncertainty when it comes to estimates of particular sources of loss like entrainment (Smith 2019; Smith et al. 2020) or flow-related survival (Polansky et al. 2021; Kimmerer and Gross 2022). The Service anticipates injury and mortality of individual delta smelt and longfin smelt will occur as a result of entrainment and whenever habitat conditions do not support the successful completion of the species' full life cycles.

Take from South Delta Entrainment

The OMR index is an indicator for how export pumping at Banks and Jones Pumping Plants influence hydrodynamics in the South Delta. The Service has determined for the purposes of this BiOp that delta smelt and longfin smelt that enter the Old and Middle river corridors are entrained whether or not they survive long enough to reach the Banks and Jones pumping plants or other South Delta facilities including the fish collection facilities, Clifton Court Forebay, agricultural barriers, and the Rock Slough intake. Adult delta smelt have substantial capacity to control their distribution in the Bay-Delta. Thus, some adult delta smelt and longfin smelt may 'entrain' themselves during their winter dispersal by cueing on hydrodynamics resulting from the export of water by Banks and Jones Pumping Plants while moving up the San Joaquin River (Gross *et al*. 2021). Delta smelt and longfin smelt larvae have some ability to control their distribution but less than older, more competently swimming life stages, making them more vulnerable to tidal currents and the net displacement (or flow) of water over multiple tidal cycles. Delta smelt and longfin smelt are attracted to turbidity in open-water habitats. The hydrodynamic conditions indexed by net negative flow in Old and Middle rivers can affect the dispersal of turbidity into and through the South Delta. During winter dispersal and spring spawning, when turbidity of more than 12 FNU is present in Old and Middle rivers, adult delta smelt may be more likely to move into these channels, become entrained, and become subject to the reduced quality habitat in the channels, adjoining canals, and associated flooded islands (e.g., Mildred Island) due to operations, or be injured or killed as a result of entering the export facilities. Adult longfin smelt are proportionally less likely than delta smelt to migrate far enough into the South Delta to be entrained. Additionally, entrained adult delta smelt and longfin smelt may spawn in areas where their progeny will be lost to the population due to some unquantifiable combination of predation loss associated with submerged vegetation or eventual transport to the CVP and SWP facilities. The number of longfin smelt subject to these forms of take is likely to be relatively low given that most individuals spawn in the low-salinity zone.

The conditions in the South Delta that result from net negative flows and elevated turbidity cue movement of adult delta smelt and longfin smelt into the area and can be causally linked to the level of incidental take of individuals and some of their offspring due to entrainment caused by operations. These conditions encompass all areas influenced by the hydrodynamic effects of export pumping at Banks and Jones Pumping Plants, including the other South Delta facilities that do not factor into the OMR index calculation. Proposed OMR protective measures minimize, but do not eliminate, the likelihood of entrainment. The following thresholds are directly related to the specific ecological conditions in the South Delta that reflect the conditions commensurate with the level of incidental take through entrainment that is anticipated in this BiOp.

The incidental take of delta smelt and longfin smelt will be exceeded if:

- The 14-day average OMR index is more negative than -5,000 cfs from January 1 through the date that the 3-day average water temperature at Clifton Court Forebay is 77°F (25°C) or June 30, whichever occurs first; OR starting December 1 if an Adult Longfin Smelt Entrainment Protection Action has been triggered (per *BA Section 3.7.4.2*);

- OR the 14-day average OMR index is more negative than -2,000 cfs for any of the 14 consecutive days of the First Flush Action. The First Flush Action must be in place within three days of being triggered and could be triggered anytime between December 1 and February 28 (February 29 in a leap year) (per *BA Section 3.7.4.2*);

- OR the 14-day average OMR index is more negative than -6,250 cfs during a storm flex operation as described in *BA Section 3.7.4.6*;

- OR the 14-day average OMR index is more negative than -3,500 cfs during periods in which Secchi disk depth or turbidity levels require the extra protection (per *BA Sections 3.7.4.4* and *3.7.4.5*) unless a high flow offramp is in effect (per *BA Sections 3.7.4.4* and *3.7.4.5.2*);

- OR Reclamation's export reductions intended to generate outflow targets of 87.5 TAF (above normal years), 62.5 TAF (below normal years), and 62.5 TAF (dry years) between March and May of the pre-adoption period of the HRL are not met and DWR does not operate to its ITP's project description.

- The conditions identified as commensurate with the anticipated level of incidental take will be maintained unless offramped as agreed to following governance procedures or modified through the adaptive management governance process outlined in the PA. If offramped or modified, the conditions that result will be the ecological condition commensurate with the level of incidental take through entrainment. If the thresholds described above or other thresholds resulting from the offramp governance procedures described in the PA are met, the amount or extent of the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

Take from North Delta SWP Diversions

The operation of the Barker Slough Pumping Plant can result in predicted entrainment from within Barker and Lindsey sloughs but the hydraulic draw of water from outside of Lindsey Slough is too small or too slow to result in likely fish entrainment. The hydrodynamic conditions created by the Barker Slough Pumping Plant are therefore anticipated to entrain all larval delta smelt and longfin smelt that were spawned only in Barker and Lindsey sloughs. The Service anticipates that incidental take of delta smelt and longfin smelt larvae will occur at the Barker Slough Pumping Plant (BSPP). Incidental take is expected to be low to zero for post-larval life stages since BSPP has positive barrier fish screens making injury or death of adult and juvenile delta smelt and longfin smelt unlikely. However, a small number of larval delta smelt and longfin smelt may be killed through impingement, entrainment, or sediment and aquatic weed removal.

Hydrodynamic conditions related to the rate of diversion at the BSPP influence the likelihood of delta smelt and longfin smelt being drawn into the BSPP. As the diversion rate increases, the likelihood of entrainment into BSPP instead of local agricultural diversions increases. Therefore, the diversion of water at BSPP can be causally linked to the level of incidental take of delta smelt and longfin smelt due to entrainment, impingement, or during sediment and aquatic weed removal caused by operations of the BSPP. The following thresholds are directly related to the conditions associated with water diversion at BSPP that are commensurate with the maximum level of incidental take anticipated in this BiOp.

The incidental take of longfin smelt will be exceeded if pumping at Barker Slough Pumping Plant exceeds a 7-day average diversion rate of 100 cfs in a Critical or Dry year from January 1 through March 31.

The incidental take of delta smelt will be exceeded if:

- pumping at Barker Slough Pumping Plant exceeds a 7-day average diversion rate of 100 cfs in a Critical or Dry year from May 1 through June 30 once a 20-mm Survey catch trigger has been met or exceeded (per *BA Section 3.7.13.1.2.2*);

- OR pumping at Barker Slough Pumping Plant exceeds a 7-day average diversion rate of 60 cfs in a Critical or Dry year from March 1 through April 30 once a 20-mm Survey catch trigger has been met or exceeded (per *BA Section 3.7.13.1.2.2*).

If the thresholds described above are met, the amount or extent of the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

It is anticipated that the PA will increase the use of Suisun Marsh by delta smelt via the Summer-Fall Habitat Action, but delta smelt and longfin smelt frequently reside in the larger sloughs of Suisun Marsh and less frequently reside in the marsh's smaller sloughs. The Roaring River Distribution System (RRDS) and the Morrow Island Distribution System (MIDS) are used to deliver fresh water flowing into Montezuma and Suisun sloughs to adjacent wetlands and to drain water off of these wetlands. The use of these distribution systems entrains fish. Thus, the Service anticipates that incidental take of delta smelt and longfin smelt larvae will occur at the RRDS and take of delta smelt and longfin smelt larvae, juveniles, and adults will occur at the MIDS, which is unscreened. Incidental take for both species is expected to be low. The RRDS intake has positive barrier fish screens which limit fish loss and the approach velocity toward these screens is generally low. Therefore, the presence of the screen and approach velocities maintained can be causally linked to incidental take from operation of the RRDS. The MIDS is unscreened, and because of that approach velocities vary more than at RRDS. The diversion of water into MIDS and the distribution of that water onto adjacent wetlands can be causally linked to take of delta smelt and longfin smelt due to entrainment and subsequent stranding into canals and shallow wetlands where the chance of survival is much lower. The RRDS has not been considered a major source of fish loss since it was screened and the MIDS is likewise not known to be a major source of smelt entrainment. There has been no proposed change to the use of either RRDS or MIDS which have been in operation since 1979 or 1980.

The following specific ecological conditions reflect the conditions commensurate with the level of incidental take through operation of RRDS and MIDS that is anticipated in this BiOp.

- Approach velocity at the screens is limited to 0.2 ft/second except during mid-September – mid-October, when RRDS diversion rates are controlled to maintain a maximum approach velocity of 0.7 ft/second for fall flood up operations.

- There will be no change to the general timing and quantities of water diverted into and through MIDS.

If the conditions described above are not maintained, the amount or extent of the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

Take from Far-field Effects of Operations

There will be areas outside of the influence of entrainment in the range of delta smelt and longfin smelt that will be affected by reduced habitat quality resulting from operations of the CVP and SWP. The ecological conditions resulting from the hydrodynamic effects of the operations and diversion of freshwater flows include reduced size and extent of low-salinity habitat in the spring and summer. Implementation of the Summer-Fall Habitat Action, which includes operations of the SMSCG in the summer and maintaining X2 at 80 km in the fall (per BA Section 3.7.6), will result in an ecological condition that includes improved habitat quality and quantity in the area of low-salinity habitat. Additional studies as proposed under adaptive management for the Summer-Fall Habitat Action will be implemented and may result in operational changes that maintain or improve the habitat conditions in low-salinity habitat that would be expected from implementing the Summer-Fall Habitat Action as described in BA section 3.7.6. Injury and mortality of sub-adult delta smelt and longfin smelt are anticipated to be minimized by these measures as described in the PA. Although some longfin smelt are likely to reside near the low-salinity zone in the summer and fall, many are expected to reside more seaward given their increased tolerance to salinity as compared to delta smelt. Therefore, the number of longfin smelt subject to injury or mortality from reduced habitat quality and quantity is expected to be relatively low.

If the conditions described above are not maintained, the amount or extent of the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

Take from Adaptive Management Actions

Implementation of actions identified in the Adaptive Management Plan will entail additional monitoring and research to carry out elements of the program under the direction of a steering committee. The actions under the program are categorized into bins correlated with their anticipated timeframe for their completion and possible implementation into decision-making tools or in some cases, as future actions. The Adaptive Management Plan includes a governance structure and decision-making process that will help ensure studies are designed to meet their intended purposes while minimizing or avoiding incidental take. If operations are modified as a result of the adaptive management process, the ecological conditions described above in this incidental take statement may change to reflect those actions depending on how operations are changed.

The following adaptive management actions may entail abiotic or biotic monitoring that may result in injury or mortality of delta smelt or longfin smelt: Summer-Fall Habitat Action for delta smelt, Efficacy of Suisun Marsh Salinity Control Gate operations, Experimental Food Enhancement Actions, Tidal Habitat Restoration Effectiveness, Longfin Smelt Science Plan Actions, Delta Smelt Supplementation, Spring Delta Outflow. The Service anticipates that incidental take of all life stages of delta smelt and longfin smelt will occur as the result of implementation of adaptive management actions. Incidental take is expected to be low since measures to minimize the number of individuals affected will be incorporated into study designs by the AMTs. A small number of delta smelt and longfin smelt will likely be captured or come into contact with in-water gear. If monitoring is addressed under existing, valid consultations, then the incidental take is exempted through those consultations. Because these actions are addressed as a stand-alone programmatic consultation, additional supporting information on implementation will be provided to the Service to confirm if those actions are consistent with the effects analyzed and any resulting incidental take identified in this document. If these adaptive management actions are implemented differently from what is approved by the Service through the governance process described in the Adaptive Management Plan, the amount or extent of the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

Giant Garter Snake

The Service anticipates incidental take of GGS is reasonably certain to occur. The Service is unable to quantify the exact number of snakes that could be affected as a result of the PA. The Action Area with regard to GGS is thousands of acres and it would be impossible to know when and where or how many GGS would be present within the Action Area when water reductions are implemented. GGS are secretive, cryptic, and highly sensitive to human activity. They are extremely difficult to detect unless observed undisturbed at a distance. In instances in which the total number of individuals anticipated to be taken cannot be determined, the Service may use the amount of habitat impacted as a surrogate. Since take is expected from effects to habitat through cropland idling/shifting resulting in less water in aquatic habits for the GGS to utilize for their essential behaviors such as feeding, breeding, and sheltering, the quantification of amount of habitat affected becomes a direct surrogate for all the individual GGS within that habitat.

The Service anticipates that an annual maximum amount of rice acreage to be fallowed will be 83,333 acres during the first ten years of water reductions caused by implementation of the Shasta Framework (2025-2035) and 16,667 acres during the following ten years (2035-2045). The total number of actual acres of croplands that would be idled/shifted is unquantifiable based on the information that Reclamation provided. Not all of the habitat within the Action Area are occupied nor do all of the properties subject to water reductions have known GGS occurrences within or near their properties. GGS also use the linear features of irrigation canals primarily as their preferred habitat as opposed to the large open acreages of the shallow water environment of a rice field. The Service anticipates that only a fraction of the total acreages that may be fallowed would result in effects to GGS. These water reduction actions will only occur in critical water year types, so not all years will be affected by crop idling/shifting. The action will result in the loss of an undetermined number of individual snakes through increased mortality levels of adults and juveniles due to decreased prey availability, reduced reproduction by snakes, and/or mortality of snakes due to predation as they may move out of areas subject to cropland idling/shifting. This level of incidental take will be considered exceeded, and reinitiation will be required pursuant to 50 CFR 402.16, if the amount of rice acreage fallowed as a result of implementation of water reductions under the Shasta Framework exceeds 83,333 acres in any year between 2025-2035, and/or if the amount of rice acreage fallowed exceeds 16,667 acres in any year between 2035-2045.

Northwestern Pond Turtle

The Service anticipates that incidental take of the northwestern pond turtle will be difficult to detect because of their life history. Northwestern pond turtles can be difficult to locate due to their cryptic appearance. Finding a dead or injured individual is unlikely due to not being able to access locations where carcasses may end up, and scavengers eating the carcasses. Losses of northwestern pond turtles may also be difficult to quantify due to the lack of information on how they are affected by the PA, random environmental events, changes in hydrology, and/or additional environmental disturbances. However, while it will not be possible to detect all turtles taken, we expect that monitoring during implementation of activities within northwestern pond turtle habitat will result in detection of some individuals that can be moved from harm's way and some individuals that are killed or injured. Turtles that are relocated will be subject to sublethal and potentially lethal take associated with capture. Therefore, the Service anticipates that all northwestern pond turtles within the Action Area may be subject to incidental take in the form of harassment. In addition, the Service anticipates that no more than ten (10) northwestern pond turtles will be subject to incidental take in the form of death, injury, or harm each calendar year, and not more than fifty (50) every 10 years.

Given the difficulty in detecting dead or injured individuals, if more than two (2) dead or injured northwestern pond turtles are reported in a calendar year, or if more than ten (10) dead or injured northwestern pond turtles are reported over 10 years, the anticipated level of incidental take will be considered exceeded and reinitiation will be required pursuant to 50 CFR 402.16.

19. Effect of the take

In the accompanying biological opinion, the Service determined that the level of anticipated take is not likely to result in jeopardy to the delta smelt, longfin smelt DPS, northwestern pond turtle, and giant garter snake.

20. Reasonable and Prudent Measures

The Service has determined that the following reasonable and prudent measures are necessary and appropriate for the delta smelt, longfin smelt, northwestern pond turtle, and giant garter snake:

1. Reclamation and DWR shall minimize the impact of incidental take of delta smelt and longfin smelt from operations of the CVP and SWP.

2. Reclamation and DWR shall minimize the impact of the of incidental take of delta smelt from operations of the Bay-Delta Division.

3. Reclamation and DWR shall minimize the impact of the incidental take of northwestern pond turtles from operations of the CVP and SWP.

4. Reclamation shall minimize the impact of incidental take of giant garter snakes from operations of the Shasta Division.

5. Reclamation and DWR shall monitor and report the amount and extent of take of delta smelt, longfin smelt, and northwestern pond turtle to the Service. Reclamation shall monitor and report the amount and extent of take of giant garter snake to the Service.

21.Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the Act, Reclamation and DWR shall comply with the following terms and conditions, which implement the reasonable and prudent measures described above and include required reporting/monitoring requirements. These terms and conditions are nondiscretionary.

The following terms and conditions implement reasonable and prudent measure 1:

a. Reclamation and DWR shall implement the proposed operational measures as described in the PA.

b. Reclamation shall ensure that any operational decisions from the Shasta Operations Team that may impact operations or effects in the Bay-Delta are communicated to all WOMT agencies prior to implementation.

c. Reclamation and DWR shall ensure that the proposed WOMT charter is completed by February 28, 2025. In order to ensure WOMT is prepared to make fully informed decisions in a timely manner, this charter shall address, but is not necessarily limited to, the following items:

    i. A description of how information and requests for decisions are communicated from working teams to WOMT and vice versa (including timelines) and process for assuring independent work team deliberations;

    ii. A list of proposed operational measures that may require input or decisions from WOMT;

    iii. A commitment that any initial operational variances from the PA and all supporting information for those proposed variances must be described in writing by the proposing agency (or agencies) to all WOMT agencies as soon as practicable, which should generally be at least 24 hours prior to the weekly WOMT meeting. This will ensure timely and fully informed decision-making. The supporting information shall describe if and how the proposed variance is or is not within the effects analyzed and is or is not within the amount or extent of incidental take anticipated in this BiOp, and may be supplemented by additional input developed within 24 hours of WOMT;

iv. A description of the process for elevation to sub-Directors or Directors for final decisions, when necessary;

v. A description of the process for communicating final decisions and verification of operational changes to all of the WOMT agencies; and

vi. A commitment to consider facilitation for WOMT meetings by a floating, independent facilitator (or team of facilitators).

d. DWR, in coordination with Reclamation, the Service, NMFS, and CDFW shall develop a Standard Operating Procedures document for the operation of diversions into the Roaring River Distribution System. This document shall demonstrate how RRDS is operated to maintain specified approach velocities. This document shall be finalized before the 2025 fall flood up season.

The following terms and conditions implement reasonable and prudent measure 2:

a. Reclamation shall continue to support development of the Delta Smelt Supplementation Program. This support includes:

i. Assisting the Service in development of a Hatchery and Genetic Management Plan (HGMP) that will provide a detailed overview of the Delta Smelt Supplementation Program's operational components for each stock captively reared at a facility. Final review and approval of the initial HGMP will be completed by the Service. The HGMP is intended to be a "living document" that will guide sound hatchery management activities for delta smelt supplementation ensuring the well-being and caretaking of the captive delta smelt broodstock. The HGMP will document the actions being taken such as husbandry techniques, fish health, nutrition, spawning methods, behavior, handling, and transport and release strategies. Revisions to the HGMP will be coordinated with the Service and informed by the Culture and Supplementation of Smelt (CASS) group to review program success and critical actions that require undertaking including: production numbers, genetically sound management, revealing new information from monitoring and research that lead to improving hatchery practices, review of previous propagation efforts, direction of the program into new locations and/or continued releases in current planting areas, and other monitoring results. Effort will be put into rebuilding the natural population through the broodstock collections and taking a safeguard against extinction approach to build population numbers, genetically link broodstock to the wild population, and guard against catastrophic failure.

ii. Minimizing impacts to delta smelt during the capture, transport, spawning, rearing, and release phases of the broodstock development process.

iii. Continuing to support studies that evaluate post-release survival and recruitment which are critical to understanding the success of the Delta Smelt Supplementation program to offset loss of individuals from operations of the SWP and CVP.

iv. Working with the Service to identify and design compliance and effectiveness monitoring tools, which may include life cycle models and the more traditional in-water monitoring methodologies, to evaluate the Delta Smelt Supplementation Program accomplishments that are expected to occur.

v. Preparing reports in collaboration with the Service, and other CASS members, on an annual frequency regarding Delta Smelt Supplementation Program evaluations, upcoming activities, accomplishments, lessons learned, and areas to adaptively manage to further achieve the goals and objectives of the program. All final reports shall be provided in electronic format to the Service.

vi. In a coordinated manner with the Service, securing additional infrastructure (space, tanks, laboratory supplies and equipment, etc.) as necessary, to ensure the broodstock program can be maintained securely and successfully to meet production targets identified in the PA.

b. Reclamation and DWR shall ensure that the proposed tidal habitat restoration projects are constructed, protected, and managed by the year 2026. Reclamation and DWR shall follow the process outlined in Appendix A, Attachment 2: Tidal Habitat Restoration Administrative Process and Documentation Requirements of the BA. Documentation described in Section A2.2 and the flowcharts in this appendix shall be submitted to the Service for review and approval no later than July 31, 2026.

The following terms and conditions implement reasonable and prudent measure 3:

a. Reclamation and DWR will report any northwestern pond turtles identified in the Action Area to the Service within 72 hours and reported to CNDDB.

b. If northwestern pond turtle is observed to be in harm's way within the Action Area, qualified Reclamation or DWR staff may move the turtle to the nearest aquatic habitat and notify the USFWS within 72 hours of event.

c. Reclamation and DWR will report any turtle carcasses found in and around the CVP and SWP facilities, as well as location of the remains to the Service for identification within 72 hours to better understand the interaction of the PA with northwestern pond turtle.

d. Reclamation and DWR staff will observe posted speed limits on roads used to access facilities to reduce the likelihood of vehicle strikes.

The following terms and conditions implement reasonable and prudent measure 4:

a. Reclamation will monitor the GGS response to crop idling/shifting which will include annual sampling of GGS within the Action Area with focuses on GGS occupancy and distribution. Measures should be comparable to research that has been ongoing since 2015. Reclamation will provide the results of the proposed monitoring and snake detections to the Service on an annual basis.

The following terms and conditions implement reasonable and prudent measure 5:

a. Reclamation will provide a report annually to the Service which describes implementation of real-time operations of Old and Middle River Management/Seasonal Operations. This report shall include information on environmental conditions, flows, temperature, salinity, turbidity, fish and other biotic monitoring, species distribution, delta smelt and longfin smelt salvage, fish genetic identification, fish condition, and other parameters as agreed to in coordination with the Service. This report will describe implementation and/or non-implementation of the proposed OMR protection measures. If any measures were not implemented as described in the PA, a description of why the measure was modified or not implemented will be provided in the report.

b. For adaptive management actions and studies developed under the Adaptive Management Plan and associated appendices, Reclamation and/or DWR will provide the following information to the Service as outlined in the *Stand-Alone Programmatic Consultation* subsection of the *Consultation Approach* section of this BiOp for any of these actions that may affect listed species and/or critical habitat addressed in this BiOp:

    i. Individual project description

ii. Individual project environmental baseline

iii. Confirm project components were described/evaluated at the program level

iv. Confirm project-specific effects were evaluated at the program level

v. Confirm project-specific action area is within the programmatic action area

vi. Confirm no new information on the species/critical habitat would modify the effects in the stand-alone programmatic consultation

vii. Confirm project-specific effects were evaluated in this BiOp

viii. Confirm the section 7(a)(2) conclusion in this BiOp has not changed for the species affected in the specific action.

This information will be provided to the Service no later than 90 days prior to the planned implementation of any actions (or such time as agreed to by the AMT) at the start of an adaptive management action or study) in order to allow adequate time to either confirm the action or study is within the effects analyzed or triggers reinitiation.

c. Reclamation and DWR shall report to the Service on the results of the planning, structured decision making, and implementation of the Summer-Fall Habitat Action. This reporting shall include details regarding how and if the SMSCG were operated and how the 80 km X2 action was implemented if applicable (unless modified through the adaptive management process). This report shall be submitted to the Service annually no later than July 31 of the following year.

d. For all lands subject to cropland idling/shifting due to water reductions caused by implementation of the Shasta Framework, Reclamation will request from the

Sacramento River Settlement Contractors information about acreages and locations that were fallowed as a result of water reductions. If this information is provided, Reclamation will submit the information to the Service.

Reporting Requirements

In order to monitor whether the amount or extent of incidental take anticipated from implementation of the PA is approached or exceeded, Reclamation shall adhere to the following reporting requirements. Should the anticipated amount or extent of incidental take be exceeded, Reclamation must reinitiate formal consultation in accordance with 50 CFR 402.16.

1. Comply with reporting requirements included in the above Terms and Conditions.

2. The Service must be notified within 24 hours of the finding of any injured or dead delta smelt, longfin smelt, northwestern pond turtle, or giant garter snake or any unanticipated damage to its habitat associated with the PA. Notification will be made to the contact below and must include the date, time, and precise location of the individual/incident clearly indicated on a U.S. Geological Survey 7.5 minute quadrangle or other maps at a finer scale, as requested by the Service, and any other pertinent information. When an injured or dead individual is found, Reclamation (for delta smelt, longfin smelt, northwestern pond turtle or giant garter snake) and DWR (for delta smelt, longfin smelt, or northwestern pond turtle) shall follow the steps outlined in the Disposition of Individuals Taken section below.

3. Sightings of any listed or sensitive animal species shall be reported to the Service and CNDDB (https://www.wildlife.ca.gov/Data/BIOS).

Disposition of Individuals Taken

Injured or dead delta smelt or longfin smelt observed in salvage should be preserved in a container of at least 70% Ethanol containing a paper with the date and time when the animal was found, fork length, the location where it was found, and the name of the person who collected the specimen. The preserved specimens are then to be evaluated by an onsite Service-approved biologist who verifies species identification and examines the fish for reproduction maturity and stage. A second fish identification verification is provided by staff of the CDFW or alternatively DWR or Reclamation staff, if needed. Fish specimens confirmed as delta smelt or longfin smelt must be stored until custody is transferred to the CDFW for archiving. Annually, a catalog of archived samples transferred from Reclamation and DWR salvage facilities will be reported.

Injured listed species must be cared for by a licensed veterinarian or other qualified person(s), such as a Service-approved biologist. Dead individuals must be sealed in a resealable plastic bag containing a paper with the date and time when the animal was found, the location where it was found, and the name of the person who found it, and the bag containing the specimen frozen in a freezer located in a secure site, until instructions are received from the Service regarding the disposition of the dead specimen. The Service contact person is the Assistant Field Supervisor of the Endangered Species Division at (916) 930-2664.

For all required reporting outlined above, reports will be provided to the Service's San Francisco Bay-Delta Fish and Wildlife Office. Reports will be provided electronically to the Assistant Field Supervisor of the Endangered Species Division unless directed otherwise.

22. Conservation Recommendations

Section 7(a)(1) of the Act directs Federal agencies to utilize their authorities to further the purposes of the Act by carrying out conservation programs for the benefit of endangered and threatened species. Conservation recommendations are discretionary agency activities to minimize or avoid adverse effects of a proposed action on listed species or critical habitat, to help implement recovery plans, or to develop information. The Service recommends the following actions:

1. The U.S. Bureau of Reclamation and the California Department of Water Resources should coordinate with their respective Farm Bureaus and end water users to work to incentivize crops that require less water, and funding both the research and delivery of more efficient methods of water use to end water users.

2. The Service recommends that Reclamation and DWR participate in recovery planning and implementation of conservation actions consistent with recovery planning documents.

3. Directly conduct or fund research projects to address current information gaps in the federally-listed species life history, conservation strategies, and recovery needs in the Bay-Delta and Central Valley.

4. Encourage adaptive management of storage, flows and conservation of water to benefit federally-listed species.

5. Work to secure long-term water sources to support riparian habitat restoration activities in Refuges.

6. Develop and implement a riverine ecosystem mitigation and adaptive management plan to avoid and compensate for the long-term impacts of altered flow regimes on riparian and wetland communities to benefit a broad range of threatened and endangered species in the Action Area.

7. Encourage or require the use of appropriate California native species in restoration efforts.

In order for the Service to be kept informed of actions minimizing or avoiding adverse effects or benefiting listed species or their habitats, the Service requests notification of the implementation of any conservation recommendations.

23.Reinitiation

This concludes formal consultation on the Coordinated Long-Term Operation of the Central Valley Project and State Water Project. As provided in 50 CFR §402.16,

(a) Reinitiation of consultation is required and shall be requested by the Federal agency, where discretionary Federal involvement or control over the action has been retained or is authorized by law and:

(1) If the amount or extent of taking specified in the incidental take statement is exceeded;

(2) If new information reveals effects of the action that may affect listed species or critical habitat in a manner or to an extent not previously considered;

(3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the BiOp or written concurrence; or

(4) If a new species is listed or critical habitat designated that may be affected by the identified action.

(b) An agency shall not be required to reinitiate consultation after the approval of a land management plan prepared pursuant to 43 U.S.C. 1712 or 16 U.S.C. 1604 upon listing of a new species or designation of new critical habitat if the land management plan has been adopted by the agency as of the date of listing or designation, provided that any authorized actions that may affect the newly listed species or designated critical habitat will be addressed through a separate action-specific consultation. This exception to reinitiation of consultation shall not apply to those land management plans prepared pursuant to 16 U.S.C. 1604 if:

(1) Fifteen years have passed since the date the agency adopted the land management plan prepared pursuant to 16 U.S.C. 1604; and

(2) Five years have passed since the enactment of Public Law 115-141 [March 23, 2018] or the date of the listing of a species or the designation of critical habitat, whichever is later.