UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Refer to NMFS No: WCR-2019-11447

MAY 10, 2019

David M. Mooney
Area Manager
Bay-Delta Office
U.S. Bureau of Reclamation
801 I Street, Suite 140
Sacramento, California 95814-2536

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

Dear Mr. Mooney:

Thank you for your letter of December 10, 2018, requesting initiation of consultation with the National Marine Fisheries Service (NMFS) pursuant to section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 et seq.) for the proposed Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, in Yolo County, California.

Thank you, also, for your request for consultation pursuant to the essential fish habitat (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action. After reviewing the project, we concluded that the action would adversely affect EFH, and have therefore included the results of that review in Section 3 of this document.

This biological opinion is based on the final biological assessment and other related environmental permitting documents prepared in support of the project, and on the best available scientific and commercial information. NMFS concludes that the project is not likely to jeopardize the continued existence of the federally listed as endangered, Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), the threatened Central Valley spring-run Chinook salmon ESU (*O. tshawytscha*), the threatened California Central Valley steelhead distinct population segment (DPS) (*O. mykiss*), or the threatened southern DPS of the North American green sturgeon (*Acipenser medirostris*), and is not likely to destroy or adversely modify their designated critical habitats. NMFS has included an incidental take statement with reasonable and prudent measures and nondiscretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

This project is intended to meet Reasonable and Prudent Alternative (RPA) Actions I.6.1 and I.7, described in the *Biological and Conference Opinions on the Coordinated Long-term Operations of the Central Valley Project and State Water Project* (NMFS 2009). RPA Action I.7 is fully met

by the project. The project, in combination with the restoration actions taken in response to the United States Fish and Wildlife Service's *Biological Opinion on the Coordinated Operations of the Central Valley Project and the State Water Project in California* (USFWS 2008) will likely fully meet RPA Action I.6.1.

Please contact Doug Hampton in our California Central Valley Office located in Sacramento, California at (916) 930-3610, or by electronic mail at douglas.hampton@noaa.gov, if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

Maria Rea
Assistant Regional Administrator

Enclosure

cc: To the file 151422-WCR2019-SA11447
Electronic copy only:

Ms. Janice Pinero
U.S. Bureau of Reclamation
801 I Street, Suite 140
Sacramento, California 95814-2536
Jpinero@usbr.gov

Ms. Jana Affonso
U.S. Fish and Wildlife Service
650 Capitol Mall, Suite 8-300
Sacramento, California 95814
Jana_affonso@fws.gov

Ms. Karen Enstrom
California Department of Water Resources
3500 Industrial Drive
West Sacramento, California 95691
Karen.enstorm@water.ca.gov

Mr. Zachary Simmons
U.S. Army Corps of Engineers
1325 J Street
Sacramento, California 95814
Zachary.M.Simmons@usace.army.mil

UNITED STATES DEPARTMENT OF COMMERCE
National Oceanic and Atmospheric Administration
NATIONAL MARINE FISHERIES SERVICE
West Coast Region
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4700

Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project

National Marine Fisheries Service (NMFS) Environmental Consultation Organizer Number: WCR-2019-11447

Action Agency: U.S. Bureau of Reclamation

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely To Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely To Destroy or Adversely Modify Critical Habitat?
Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*)	Endangered	Yes	No	Yes	No
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern distinct population segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

Fishery Management Plan That Identifies EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	No

Consultation Conducted By: National Marine Fisheries Service, West Coast Region

Issued By:

Maria Rea
Assistant Regional Administrator

Date: May 10, 2019

TABLE OF CONTENTS

LIST OF ACRONYMS

AMM	avoidance and minimization measure
ACID	Anderson-Cottonwood Irrigation District
BA	biological assessment
BMP	best management practice
BO	biological opinion
°C	degrees Celsius
CCV	California Central Valley
CDEC	California Data Exchange Center
CDFW/CDFG	California Department of Fish and Wildlife/California Department of Fish and Game
cfs	cubic feet per second
CR	Country Road
CVP	Central Valley Project
CVRWQCB	Central Valley Regional Water Quality Control Board
dB	decibels
Delta	Sacramento-San Joaquin River Delta
DOC	dissolved organic carbon
DPS	distinct population segment
DQA	Data Quality Act
EFH	essential fish habitat
EPA	United Stated Environmental Protection Agency
ESA	Endangered Species Act
ESU	evolutionarily significant unit
°F	degrees Fahrenheit
FHWG	Fisheries Hydroacoustic Working Group
FWCA	Fish and Wildlife Coordination Act
HAPCs	Habitat Areas of Particular Concern
ITS	incidental take statement
LID	low impact development
mg/L	milligram per liter
MS4	Phase II MS4 General Permit
MSA	Magnuson-Stevens Fishery Conservation and Management Act
MSD	Mossdale Bridge CDEC station
NPDES	National Pollutant Discharge Elimination System
NMFS	National Marine Fisheries Service
NTU	nephelometric turbidity units
OHWM	ordinary high water mark
PAHs	polycyclic aromatic hydrocarbons
PBFs	physical or biological features
RBDD	Red Bluff Diversion Dam
Reclamation	U.S. Bureau of Reclamation
RMS	root-mean-square
RPMs	reasonable and prudent measures
sDPS	southern distinct population segment

LIST OF ACRONYMS CONTINUED

SFS	Stockton Fire Station precipitation station
SJR	San Joaquin River
SJRRP	San Joaquin River Restoration Program
SOC	Stockton Airport precipitation station
SRA	shaded riverine aquatic
SWE	snow water equivalent
SWRCB	State Water Resources Control Board
THMFP	total trihalomethane formation potential
TMDL	Total Maximum Daily Load
TOC	total organic carbon
UC Davis	University of California at Davis
USACE	United States Army Corps of Engineers
USFWS	United States Fish and Wildlife Service
VSP	viable salmonid population
WOUS	Waters of the United States
YOY	young-of-the-year
µg/L	microgram per liter

LIST OF TABLES

LIST OF FIGURES

1. INTRODUCTION

This Introduction section provides information relevant to the other sections of this document and is incorporated by reference into Sections 2 and 3 below.

1.1 Background

NOAA's National Marine Fisheries Service (NMFS) prepared the biological opinion (BO) and incidental take statement (ITS) portions of this document in accordance with section 7(a)(2) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 et seq.), and implementing regulations at 50 CFR 402.

We also completed an essential fish habitat (EFH) consultation on the project, in accordance with section 305(b)(2) of the Magnuson-Stevens Fishery Conservation and Management Act (MSA) (16 U.S.C. 1801 et seq.) and implementing regulations at 50 CFR 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). A complete record of this consultation is on file at the California Central Valley Office of NMFS West Coast Region located in Sacramento, California.

1.2 Consultation History

June 4, 2009 – NMFS issued a Biological and Conference Opinion on the Long-Term Operation of the Central Valley Project and State Water Project (NMFS 2009) to the U.S. Bureau of Reclamation (Reclamation). Within it were reasonable and prudent alternative (RPA) Actions I.6.1 and I.7, which are the basis for this project.

September 2012 – Reclamation and the California Department of Water Resources (DWR) issued the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan to specifically address RPA Actions I.6.1 and I.7.

December 10, 2018 – Reclamation requested initiation of consultation pursuant to the Endangered Species Act on the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project, and NMFS initiated consultation.

December 2018-April 2019 – The Yolo Bypass Consultation Scoping Group convened at the DWR West Sacramento office to discuss the consultation. There was a discussion of:

- the operational end date of March 15;
- the project description; and
- other clarifications about the consultation.

December 22, 2018 - January 27, 2019 - Consultation was held in abeyance for 38 days due to a lapse in appropriations and resulting partial government shutdown. Consultation resumed on January 28, 2019.

February 12, 2019 – Letter of sufficiency sent from NMFS to Reclamation, indicating that the December 10, 2018, consultation request package was sufficient to begin consultation.

March 14 and 22, 2019 – Management from the agencies met to discuss draft language for the adaptive management appendix C of the Environmental Impact Statement/Report, reinitiation triggers in the BO, and Terms and Conditions of the BO. Also, DWR presented the group with evidence that juvenile Chinook salmon were present in the south Yolo Bypass during multiple years when there were no overtopping events.

April 12, 2019 – The Council of Environmental Quality extended the deadline to issue a final BO from April 26, 2019, to May 10, 2019, in order to provide Reclamation an opportunity to review the draft BO.

1.3 Proposed Federal Action

"Action" within the context of the ESA 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). Similarly, the definition of a Federal action pursuant to the MSA means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910).

Reclamation intends to carry out the following activities in order to implement two actions (I.6.1 and I.7) prescribed by NMFS as part of the RPA that was issued in the 2009 *Biological and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project* (NMFS 2009).

1.3.1 *Description of Existing Facilities*

The Yolo Bypass is a leveed, 59,300-acre engineered 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. For the purpose of this project, the Yolo Bypass features two main geographical sections. The northern portion of the Yolo Bypass consists of the upper 14.2-mile section (measured north to south) between the Fremont Weir and the Interstate (I) 80 causeway (Figure 1). The southern portion consists of the lower 26.8-mile section between the I-80 causeway and the southern end of Egbert Tract.

The northern portion of the Yolo Bypass is bound to the east by the Tule Canal (the upper extension of the Toe Drain) and the east bypass levee, and to the west by the west bypass levee. The I-5 causeway bisects the northern portion of the Yolo Bypass east to west.

The southern portion of the Yolo Bypass is similarly bounded to the east by the Toe Drain and the east bypass levee (also considered the west levee of the Sacramento River Deep Water Ship Channel, downstream of the northwestern corner of Prospect Island). To the west, however, the southern portion of the Yolo Bypass is unleveed for approximately 8 miles, allowing floodwaters to flow unimpeded as far west as Yolo County Road (CR) 104. Additionally, the southern portion of the Yolo Bypass, which lies within the legally-defined Delta, has some tidally

influenced areas. Tidal conditions are routinely measured as far upstream in the Toe Drain as the I-80 causeway.

The Fremont Weir is located at the northern end of the Yolo Bypass and serves as the primary input of water flows as it conveys floodwaters from the Sacramento and Feather rivers. During major storms, additional water enters from the east through the Sacramento Weir roughly 12.5 miles south of the Fremont Weir (Figure 1), which allows additional flow onto the Yolo Bypass from the Sacramento and American rivers.

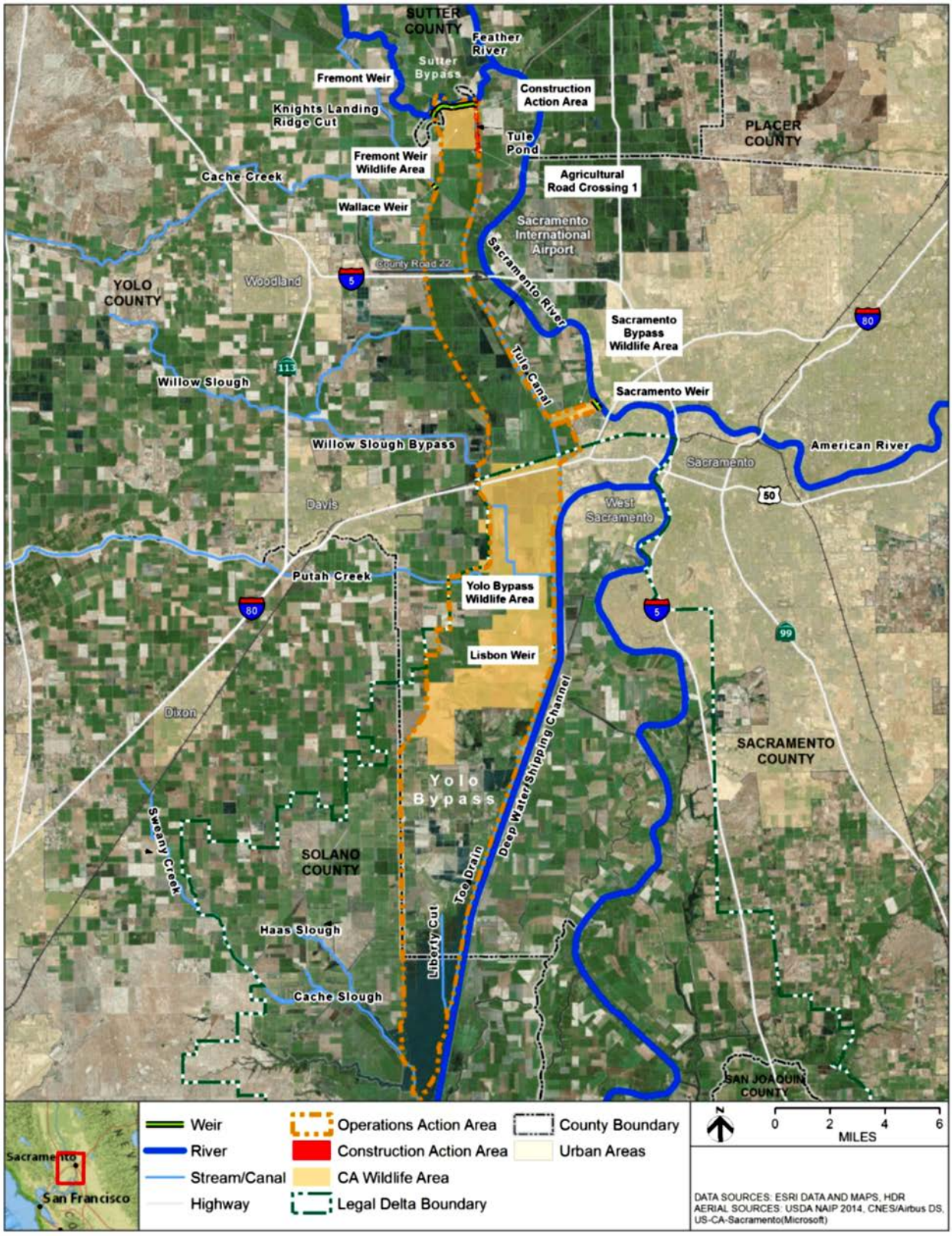

Figure 1. Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project action area. The majority of the construction will be done in the upper most extent of the Yolo Bypass but the operations of the project will affect most other areas of the bypass.

Flow also enters the Yolo Bypass from several small west side streams, including Knight's Landing Ridge Cut, Cache Creek, the Willow Slough Bypass, and Putah Creek. At times of moderate to high tributary flows, juvenile fish may navigate from the streams into the northern portion of the Yolo Bypass by way of the Tule Canal. Floodwaters from the Yolo Bypass re-enter the Sacramento River through Cache Slough. Along the eastern edge of the Yolo Bypass, the Toe Drain, a perennial tidally-influenced riparian channel, is the primary source of water during drier periods.

Inundation of the Yolo Bypass occurs in approximately 70 percent of all years, when total flow in the Sacramento River exceeds 71,000 cubic feet per second (cfs). When flooded, the Yolo Bypass provides up to 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 flooded area of the Yolo Bypass can range from 1.2 to 6 miles wide over its 41-mile length.

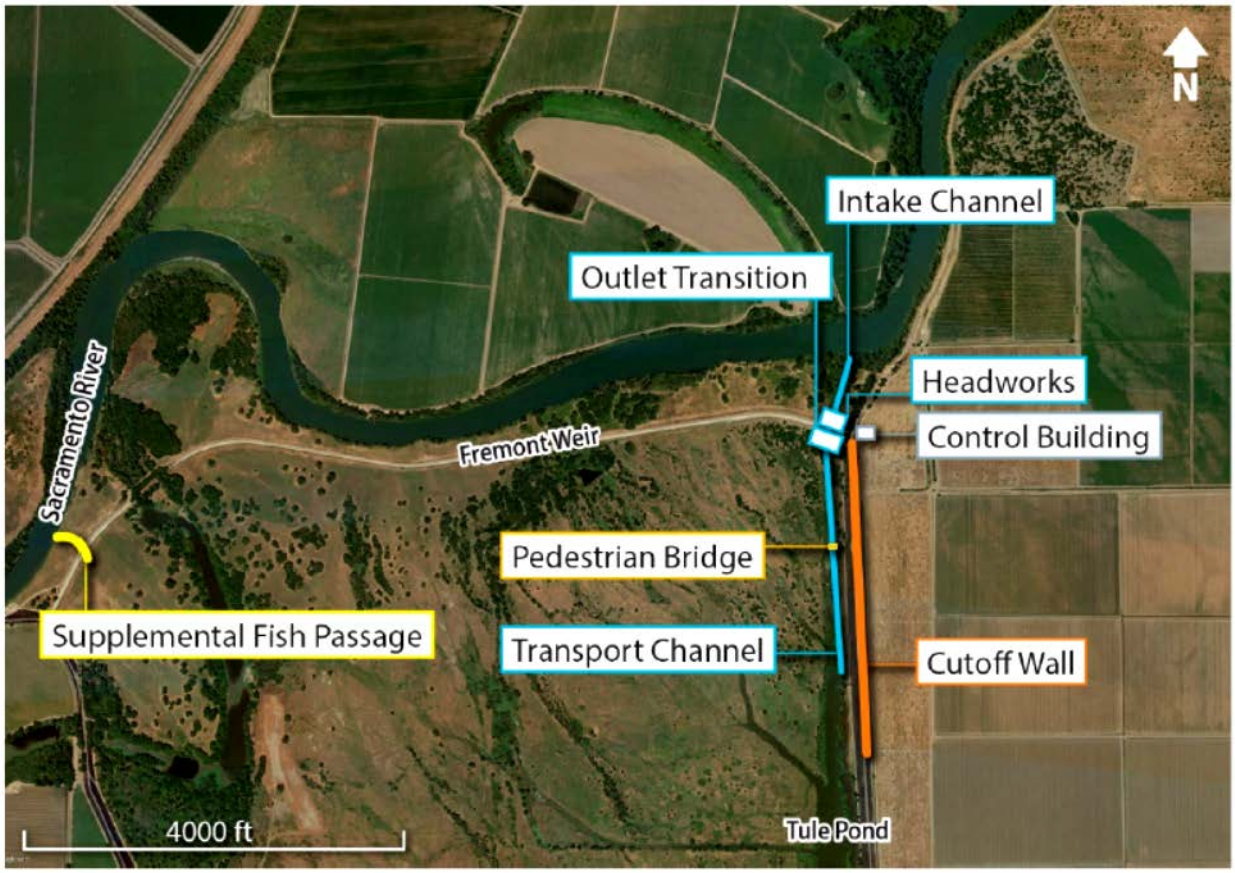

Figure 2. Description of proposed facility construction sites.

1.3.2 ***Description of Proposed Facility Construction***

1.3.2.1 Intake Channel

The primary purposes of the intake channel are to: (1) draw juvenile salmonids and floodplain inundation flows from the Sacramento River to the new headworks structure, and (2) provide upstream adult fish passage between the headworks structure and the Sacramento River. The

intake channel would be constructed with a 98-foot bottom width and 3:1 side slopes (horizontal to vertical), and the channel would be designed to have a gentle slope away from the Fremont Weir so that flows will drain toward the river. Flows from the intake channel would reach the river with an invert elevation of 12 feet (compared with the invert of 14 feet at the Fremont Weir). The downstream end of the intake channel (near the headworks at the Fremont Weir) would include a short transition from the trapezoidal intake channel to the rectangular sides of the headworks structure. To avoid scour, the channel would be lined with angular rock placed along the bank slopes and rounded rock placed along the channel bottom.

1.3.2.2 Headworks Structure

The headworks structure is designed to control the diversion of flow from the Sacramento River to the Yolo Bypass. It would also serve as the primary fish passage facility for adult fish migrating upstream to rejoin the Sacramento River, as well as provide for juvenile fish entrainment onto the Yolo Bypass through the conveyance of floodplain inundation flows emanating from the Sacramento River.

The headworks structure would be a three-bay, pile-supported, reinforced concrete structure that would bisect the existing Fremont Weir at a location along its eastern alignment. It has been designed to meet the applicable requirements for fish passage and flood control while conveying up to 6,000 cfs at a river stage of 28 feet (14 feet of water depth in the headworks structure) with all gates fully opened. The structure would house three operating control gates and include a concrete control structure, an upstream vehicular bridge crossing, and a concrete channel transition, which would transition the rectangular sides of the control structure to the side channel slopes of the outlet channel. To prevent seepage from the river, the headworks structure would have a sheet pile cutoff wall on the river side of the structure under the gates and on both sides of the structure. The gate structure would be 65 feet (upstream to downstream) by 108 feet, and the sheet piles will add 50 feet on either side of the gate structure. Debris is expected to accumulate within the Sacramento River and could affect hydraulic performance or fish passage through the headworks structure. To address this concern, debris fins are planned to be installed between the gates of the headworks structure (on the river side) to redirect debris through or over the gates rather than becoming stuck on the gate walls or facilities.

Three hydraulically or pneumatically operated, flush-mounted bottom hinge gates would be used in the headworks structure, and these gates would be able to operate under variable river elevations and overtopping events. The elevation of the top of the gate is 32 feet, which would be flush with the existing Fremont Weir crest. The upstream face of the control gates would be approximately in-line with the upstream face of the existing Fremont Weir. When fully open, the gates would be flush with the channel invert. The gates would open to allow a maximum flow of 6,000 cfs when the water surface elevation in the river reaches 28 feet. Each gate would be capable of independent operation via submersible hydraulic cylinders or inflatable reinforced bladders located beneath the gate. Mechanical and electrical control components for each gate would be housed in a control building outside of the Yolo Bypass on the eastern levee.

Stoplogs would be provided at each of the three bays in the headworks structure upstream of the control structure to dewater the gates for maintenance and as a backup closure method. Six stoplogs are required for the larger gate, and four for the two smaller gates. Installation of the

stoplogs would require a mobile crane capable of lifting approximately 10,000 pounds. Stoplogs will be stored off site and would only be installed or removed when there is no flow through the headworks structure or when the gates are closed. The stoplogs would be used to prevent groundwater or small amounts of river flow from entering the structure during maintenance activities.

A single-story, 18-foot by 18-foot concrete control building would be constructed on the eastern levee which would house a programmable logic controller (PLC) for operation of the gates, three hydraulic power units, and a motor control center. The electrical service required would be three-phase at approximately 100 amperes and 480 volts alternating current, or 80 kilovolt-amps. There will be no backup or standby emergency generator, but the units will include connections for a portable generator. Active ventilation would be required during the operation of the equipment using a roof-mounted fan that vents to the outside of the structure.

1.3.2.3 Access Structures

A reinforced concrete, three-span vehicular bridge would be built on the upstream side of the Fremont Weir to connect with the existing access road. The bridge is designed to span the channels through the new headworks structure. The bridge would be built at nearly the same alignment and elevation as the existing upstream maintenance road and would allow continued patrolling and maintenance access along the weir. The roadway of the bridge would have a width of 14 feet and an overall width of the bridge would be 18 feet. The top curb elevation would be equal to the top of the weir elevation. Temporary barrier rails (K rails) would be installed and removed such that no part of the bridge extends above the top of weir during an overtopping event. The bridge would provide a vehicular and pedestrian crossing on the northern side of the Fremont Weir. However, when water begins to flow through the new gated notch in the Fremont Weir, the channels south of the weir will fill, thereby obstructing cross channel access and potentially preventing recreational users in the Fremont Weir Wildlife Area from being able to return to their initial point of entry. To address this concern, a 130-foot-long, 8-foot-wide steel-trussed pedestrian bridge is intended to be constructed just south of the Fremont Weir (and north of Tule Pond).

1.3.2.4 Outlet Transition

The outlet transition would be a 100-foot-long reinforced concrete channel that provides a gradual hydraulic transition from the headworks into the graded transport channel. The width varies from 108 feet at the headworks to 196 feet at the transport channel. The cross section of the headworks includes three rectangular gates (one large gate with an invert elevation of 14 feet and two small gates with an invert elevation of 18 feet). The outlet transition would serve as a structure that transitions from the headworks gates to the trapezoidal downstream transport channel. The transition would be accomplished with reinforced retaining walls that flair out from the headworks abutment piers and a reinforced concrete slab-on-grade bottom, which would gradually transition into the slopes of the trapezoidal transport channel. The outlet transition would be designed to have a gentle slope consistent with the downstream transport channel.

1.3.2.5 Transport Channel

The transport channel is designed to be a graded trapezoidal channel with an interior inline bench. The interior bench is intended to help maintain acceptable velocities for fish passage at higher river elevations. The transport channel is designed to serve as the primary facility for upstream adult fish passage between the existing Tule Pond and the headworks structure, and it would also serve as the primary channel for conveying juvenile salmonids and rearing habitat flows from the headworks structure to the existing Tule Pond.

The main channel within the trapezoidal channel would have a bottom width of 30 feet. The bench would be on the east side of the channel and elevated 4 feet above the main channel, and the bench width is designed to vary between 30 and 65 feet. The side slopes (horizontal to vertical) of the trapezoidal channel would be 3:1, and the top of the channel would be approximately 150 feet wide. The channel is designed to be about 2,650 feet long with a gradual downward slope toward Tule Pond (a slope of 0.00075). The entire channel would be lined with rounded rock revetment on the channel bottom and angular rock on the bank slopes. The transport channel is designed to convey up to 6,000 cfs at a river elevation of 28 feet while maintaining velocities that permit fish passage. At the top of each side of the channel, an 8-foot-wide area with rock (a rock key) is intended to be added to reduce the potential for the channel to head cut the channel banks. The facility would have a 12-foot-wide maintenance corridor at the top of each side of the channel.

A subsurface cutoff wall made of a slurry mix primarily composed of aluminum phyllosilicate clay (bentonite) would be installed along the toe of the east bypass levee which runs immediately adjacent to the planned alignment of the transport channel. Depending on the specific soil conditions encountered at the time of installation, the bentonite slurry mix may also include cement to augment stability. The cutoff wall is intended to prevent seepage under and through the levee, and the wall would reinforce levee stability over the long term. The cutoff wall is designed to be centered 8 feet west of the east bypass levee toe and run the entire length of the transport channel, terminating roughly 200 feet beyond its downstream terminus for a total length of approximately 2,850 feet. The cutoff wall would be entirely below the surface of the channel bottom and extend to a depth of 30 feet along its entire length.

1.3.2.6 Tule Pond

The transport channel outfalls into the northern inlet of Tule Pond at an elevation of 12 feet, but allowing for an additional two feet of over-excavation in order to install the revetment and bedding material would extend the maximum depth of excavation to an elevation of 10 feet. Similarly, the outlet of Tule Pond would connect with the downstream channel located south of Tule Pond at an approximate elevation of 12 feet, with a maximum depth of excavation to an elevation of 10 feet in order to accommodate an additional 2 feet of over-excavation to install the revetment and bedding material. Pond conditions near the locations of the tie-ins with both the transport channel on the northern end of Tule Pond and the downstream channel to the south are typically dry during the late spring and summer months when construction is scheduled to occur, so dewatering may not be necessary to construct the tie-ins. If it becomes necessary to dewater either of the tie-in locations in order to complete construction, sheet pile walls would be installed to isolate localized areas of excavation and lower water levels using a series of pumps and/or

wells until the area is completely dewatered. Any dewatering efforts undertaken would be performed only on an as needed basis as dictated by site conditions, and dewatering would be localized to the vicinity of the tie-in locations rather than the entire extent of Tule Pond. During construction, access would be restricted to the levee crown road and existing operations and maintenance access routes to the tie-in locations at Tule Pond.

An additional channel is also intended to be constructed between the outfall of Tule Pond and the origin of the Tule Canal, approximately 3,294 feet to the south just downstream of Agricultural Road Crossing 1. This channel is primarily designed to facilitate upstream adult fish passage and reduce stranding between the Tule Canal and Tule Pond by connecting isolated pools that frequently develop in this wooded area as the Sacramento River flows alternate between filling and then receding from the bypass. This channel would be an engineered trapezoidal channel constructed with a 20-foot wide channel bottom and measuring 60 to 70 feet wide across the top with a 3:1 side slope (horizontal to vertical). The channel is designed to have 8 feet of revetment and a 12-foot wide maintenance corridor on each side. In addition, a subsurface cutoff wall made of a bentonite clay slurry mix, like the one previously described in conjunction with the transport channel, would also be installed parallel to this channel and centered 8 feet west of the toe of the levee in order to prevent seepage through or under the levee and reinforce long term levee stability. The subsurface cutoff wall is designed to be approximately 3,150 feet long and extend to a depth of 30 feet below the surface along its entire length.

1.3.2.7 Agricultural Road Crossing 1

Agricultural Road Crossing 1, the northernmost agricultural road crossing over the Tule Canal, is both a vehicular crossing and a water delivery feature. The crossing consists of two earthen berms that create a cross canal that conveys water across the Yolo Bypass from Wallace Weir to two 36-inch culverts that pass flow through the Yolo Bypass east levee and deliver water into the Elkhorn area for agricultural use. The top of the cross canal berms have an elevation of approximately 21 feet and hold water in Tule Pond and the wooded area to the south of the pond after Fremont Weir overtopping events. The cross canal berms effectively block flows in the Tule Canal which consequently blocks fish passage in the Tule Canal and contributes to the maintenance of high water levels in Tule Pond to the north. During the late winter and early spring months, shallow groundwater levels are high enough that they likely also contribute to the retention of water in Tule Pond and the wooded area between Tule Pond and Tule Canal. Additionally, the cross canal berms leak in some years, allowing seepage flows to both flow into and out from the wooded area when water levels are high during the wet season. Local landowners typically make periodic repairs that diminish the extent of leakage through the cross canal berms.

In order to alleviate fish passage concerns and improve the hydrologic connection between Tule Canal and Tule Pond, the channel would be re-graded and the cross canal berms would be modified to accommodate the construction of a bridge for vehicular traffic and a turnout structure on the west side of the new Tule Canal connector channel. The bridge is designed to be 18 feet wide and span 80 feet in length across Tule Canal with concrete abutments on each end. In addition, an inverted siphon consisting of two 36-inch, 270-foot-long pipes is intended to be installed beneath the new Tule Canal connector channel. The alignment of the siphon would extend from the turnout structure to a concrete junction box on the eastern side of Tule Canal

that would continue to feed the supply pipes maintaining water deliveries to agricultural users in the Elkhorn area through the existing levee. An emergency overflow bypass structure would also be installed immediately adjacent to and northwest of the turnout structure to prevent overtopping of the canal embankments into the surrounding fields during non-flood events. The overflow bypass structure is designed to discharge high flows south into the existing Tule Canal.

1.3.2.8 Supplemental Fish Passage Facility

Following completion of the Fremont Weir Adult Fish Passage Project in 2018, recently completed improvements to the Fremont Weir provide fish passage immediately after an overtopping event. The gated notch that is intended to be constructed as part of this project, as described above, would become the primary fish passage facility and main route connecting the Yolo Bypass to the Sacramento River. These two fish passage structures working in concert would greatly enhance fish passage on the eastern side of the Fremont Weir. When the weir overtops, however, fish on the western side of the Fremont Weir would be obstructed from access to these two fish passage structures as Rattlesnake Island blocks migration between the eastern and western sides of the weir. In order to alleviate this concern, an additional fish passage facility is planned to be constructed at a location along the western end of the existing Fremont Weir, providing another connection between the Yolo Bypass and the Sacramento River. This structure would allow fish that are in the stilling basin to return to the Sacramento River following an overtopping event. This supplemental fish passage structure would be located at an invert elevation of 22 feet at the Fremont Weir, and tie into the Sacramento River at an invert elevation of 20 feet through a supplemental fish passage channel that is designed to extend approximately 350 feet between the weir and the river, sloping gently away from the weir so that flows drain towards the river. The supplemental fish passage channel is designed to have a 10-foot wide channel bottom with 3:1 side slopes and connect to the 15-foot wide supplemental fish passage structure through a 10-foot long channel transition. The supplemental fish passage structure is intended to house a 15-foot wide hinge gate, recessed air bladder, and metal gate that when open, would allow up to approximately 1,000 cfs to flow into the bypass. At an elevation of 32 feet, the concrete wall of the supplemental fish passage structure would be flush with the top of the existing weir, and have a 16-foot wide traffic rated deck to allow vehicular access. Finally, a sheet pile subsurface cutoff wall is intended to be installed north of the Fremont Weir to prevent seepage or piping of water through or beneath the weir.

1.3.2.9 Construction Methods

Project construction is expected to begin in late 2020 or early 2021 and is estimated to last a total of approximately 7 months. All in-water construction activities are expected to be completed concurrently during a single construction season. Vegetation clearing will likely begin in late 2020 outside of bird breeding season (USFWS 2019). The in-water construction season would be roughly April through October, which is outside normal flood periods. Construction activities would occur from 7 a.m. to 6 p.m. each day, 6 days per week. Maintenance and equipment upkeep crews would work on equipment at night when the equipment is not in use.

Construction would begin with the demolition of a portion of the existing concrete at the Fremont Weir. The limits for demolition of the existing weir would extend a minimum of 5 feet beyond both sides of the headworks footprint to allow for excavation down to an elevation of 7

feet. A vibratory pile driver would be used to install a temporary sheet pile cofferdam to isolate the area of the construction footprint for the intake channel and the headworks structure from the waters of the Sacramento River. Once the temporary cofferdam is in place, fish capture and relocation efforts would proceed prior to dewatering of the isolated construction area in accordance with a Fish Rescue and Salvage Plan to be developed in coordination with NMFS prior to the commencement of any construction activities, which would likely include herding out of the construction site with seines, netting fish, and electrofishing if needed. Demolition activities and site preparation is expected to require approximately 1 week to complete.

Following demolition and site preparation, construction of the headworks structure, intake channel, and transport channel are intended to begin and proceed concurrently, lasting approximately 25 weeks in total. After construction of the headworks structure, installation and testing of the gates and mechanical equipment would require an additional 3 to 5 weeks. Grading of the transport channel is intended to begin at the downstream outlet (at the northern end of Tule Pond) and progress upstream toward the headworks structure, with grading of the intake channel occurring last. This sequence would avoid potential interruptions to the headworks construction and would allow construction to occur in the less saturated soil first as groundwater levels decrease with increasing distance from the Sacramento River. Groundwater levels are anticipated to be high in the spring months, so dewatering efforts would likely be necessary to complete construction of the headworks structure and the intake channel where it meets the Sacramento River. As much as 60 to 80 percent of the channel excavation work is expected to be able to be performed in dry, unsaturated soil conditions by scrapers and bulldozers. Hydraulic excavators and haul trucks would be deployed to perform any excavation work in the remaining wet, saturated soil conditions.

Excavation of the intake channel, transport channel, and all downstream facilities is expected to yield a total of 265,820 cubic yards of excess excavated material. Depending on the type of material excavated, a portion of the material could be re-used within the project area or for other nearby projects. Reclamation and DWR intend to identify and acquire approximately 7 to 8 acres of land within 2 miles of the Yolo Bypass to serve as a spoil placement site, which will receive any remaining excess excavated material and green waste generated by project activities. Any additional construction waste or debris would be transported to a nearby landfill. Any construction material imported to the project site would be obtained from existing permitted commercial sources located within approximately 65 miles of the project site, but the exact source of the materials would be determined by the construction contractor. Haul routes for these materials would be along public streets, including I-5, State Road 99, and County Roads (CR) 105, 16, 116A, and 117.

Construction easements for the project would encompass staging areas for equipment, mobilization, and spoil placement sites. After construction, staging areas are intended to be returned to pre-construction condition. Construction sites would be accessed by using I-5 to CR 117 (paved rural road), north to CR 16 (paved and dirt road), west to the Yolo Bypass east levee, and then north or south on the east levee crown road to the site. The use of CR 16 for equipment and off-site hauling would substantially degrade the quality of the road, which would require re-grading, gravelling, and potentially, repaving, to restore it to pre-construction conditions. In addition, portions of the existing levee crown roads would be used for hauling and would

consequentially require resurfacing with 6 inches of aggregate base material to restore to pre-construction conditions. The county roads and levee crown roads used for site access and haul routes would be inspected periodically during every phase of project construction. As areas of damage are identified, the damage would be temporarily repaired to accommodate ongoing operations. After all project construction activities have been completed, all roads that were temporarily repaired during construction are intended to be repaved as specified by the governing local, county, or State standards.

1.3.2.10 Operations

The goal of the project is to increase the number of migrating listed juvenile salmonids that will have the opportunity to use the Yolo Bypass for rearing. Downstream out-migration is typically triggered during the first precipitation event in the wet season. Gate operations can potentially begin on November 1 each year, and would first open in conjunction with river condition triggers. All gates would be opened when the river elevation reaches 15 feet, which is 1 foot above the lowest gate invert. At this river elevation, about 130 cfs would enter the gated notch. If the river continues to rise, the gates would stay open until the flow through the gates reaches 6,000 cfs at a river elevation of about 28 feet; at this point, the two smaller gates would be programmed to start closing until a flow of 6,000 cfs is reached and maintained (Figure 3). Gate closures are intended to be controlled so that there is not a sudden reduction in flow. The large gate would remain fully open throughout these operations. Once the Fremont Weir begins to overtop, the smaller gates are intended to remain in their last position prior to the weir overtopping (generally both would be closed at this point). After the overtopping event is over, the smaller gates are intended to open and close as needed to keep the flow through the 3 gates as close as possible to 6,000 cfs. All gates would close when the river elevation falls below 14 feet (Figure 3). Gate operations to increase inundation could continue through March 15 of each year, based on hydrologic conditions. The gates may remain partially open after March 15 to provide adult fish passage; however, flows through the gates after March 15 would not exceed the available capacity of Tule Canal (typically about 300 cfs) to avoid inundating areas outside of the canal and affecting landowners.

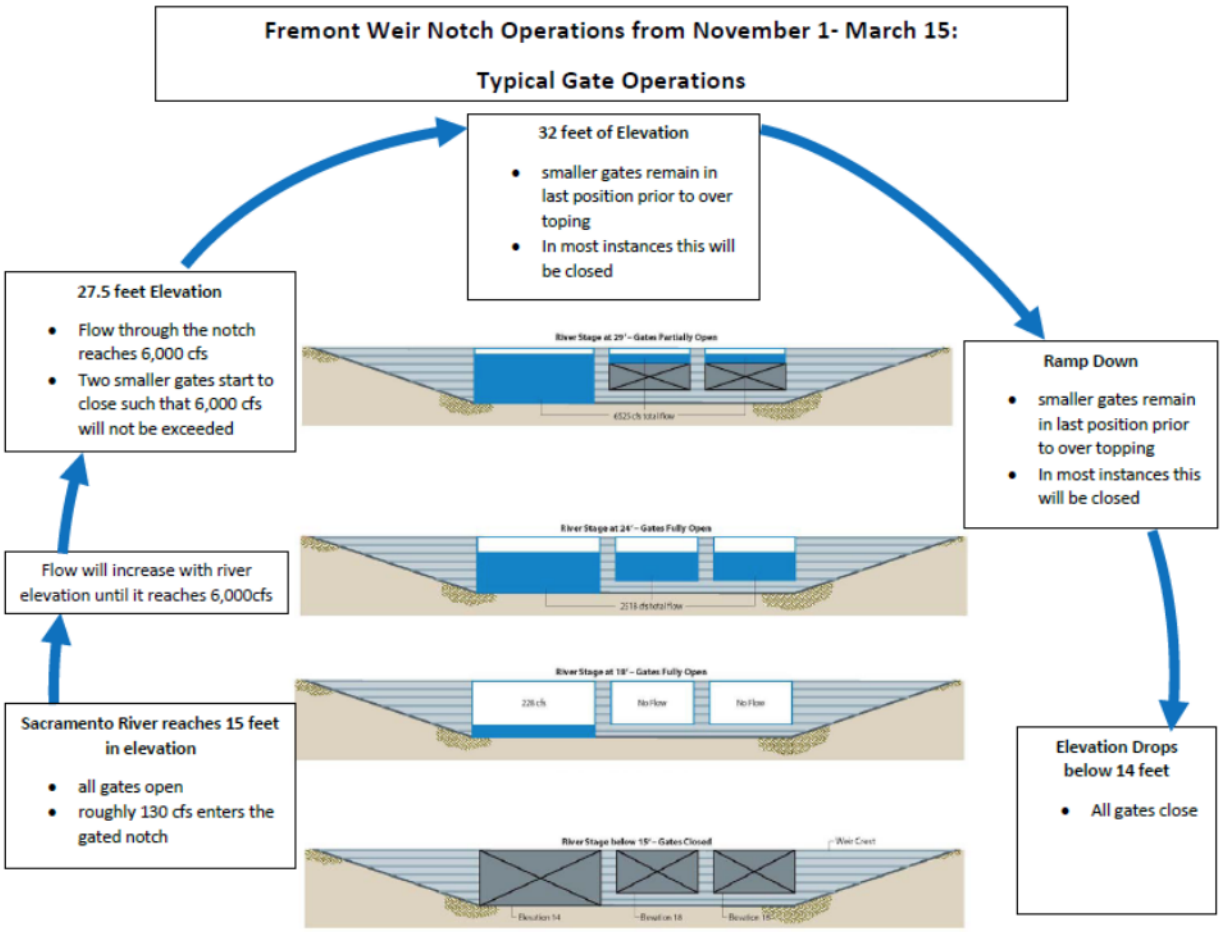

Figure 3. Fremont Weir notch operations from November 1- March 15.

1.3.2.11 Maintenance

Maintenance activities include debris removal, sediment removal, and facility inspections. The serviceability and proper function of gates, their actuators, controls, hydraulic cylinders, and the recessed areas for stoplogs and gates would be inspected after overtopping events and at the beginning and end of the flood season each year. To wash away sediment and debris that may promote corrosion by plugging drain holes and drainage pathways, the gates would be rinsed with river water, without the addition of chemicals harmful to aquatic life, at the end of the flood season each year as part of the facility inspections. The amount of sediment or debris that would be returned to the intake channel through this rinsing would be minimal. As water levels in the Sacramento River rise, some components will no longer be accessible for inspection and maintenance. Bridge guardrails are intended to be removed before the river rises to 28 feet. The installation of dewatering stoplogs can only occur when river elevation is below 14 feet or when the river elevation is between 14 and 28 feet and the gates are closed. When the river elevation is greater than 28 feet, with the gates open or partially open, there would be no safe access to the headworks or bridges. Concrete spalling or severe cracking, material corrosion, or other weaknesses and vulnerabilities identified during inspections would be noted and evaluated to determine whether repair or replacement is necessary. Any sediment deposits or accumulated debris in and around the headworks structure would be removed using an excavator or a crane.

Estimates indicate that approximately 659,000 cubic yards of sediment enter the Yolo Bypass each year under existing conditions. A portion of this sediment settles in the Yolo Bypass and must be removed through current maintenance efforts. As a result of implementing the project, sediment entering the Yolo Bypass is expected to increase to a total of approximately 743,000 cubic yards annually. Much of the additional sediment (approximately 45 percent) will settle out in the Fremont Weir Wildlife Area, while about 25 percent will settle south of Agricultural Road Crossing 1 but north of Interstate 80, and the remaining 30 percent of sediment will remain in suspension and flow out of the Yolo Bypass. Most of the sediment that settles out will be removed through flood maintenance activities in the Fremont Weir Wildlife Area, as under existing conditions. Operation of the project is anticipated to contribute an additional 37,800 cubic yards of sediment annually upstream of Agricultural Road Crossing 1. The additional deposition would primarily occur in areas that are regularly or frequently inundated, and sediment removal efforts would focus on the channel system every 5 years. Sediment loading in Tule Pond would be monitored through bathymetric surveys conducted every year. Sediment would be removed as needed in conjunction with sediment removal for flood protection in the Fremont Weir Wildlife Area. Reclamation and DWR intend to seek opportunities for the practical reuse of the sediment removed, including partnerships with local landowners to receive the excess soils or other local construction projects that may need additional materials. Local landowners would only use this additional sediment to assist in agricultural operations on their fields, not to convert agricultural land for other purposes. If no options are available for beneficial reuse of this material, Reclamation and DWR intend to purchase land outside the Yolo Bypass for disposal of the sediment removed during maintenance activities.

Maintenance activities also include vegetation removal from the project channels annually. An annual vegetation survey would be conducted and spot removal of vegetation would be performed to stop unwanted woody vegetation from establishing in and around the channels. Grasses and woody vegetation would be allowed to grow within the proposed transport channel, which is deeper than the existing ground within the Yolo Bypass. Vegetation within the channel cannot be allowed to reduce flood capacity in Yolo Bypass; therefore, grasses and woody vegetation would be maintained so that they grow no higher than the elevation of the ground adjacent to and outside of the proposed transport channel or the Tule Pond/Tule Canal within the Fremont Weir Wildlife Area. Maintenance activities such as mowing or new tree growth removal would be performed primarily during dry conditions, but maintenance could occur when the channel is wet because portions of the transport channel may have standing water throughout much of the year, including during the non-flood season from April 15 through October 31 when listed fish are not expected to be present.

1.3.2.12 Conservation Measures

The following general protection measures and best management practices will be implemented during all construction activities performed by all operations and maintenance personnel, including contracted construction personnel:

1. Construction and maintenance activities will be limited to daylight hours between 7 a.m. and 6 p.m. each day, 6 days per week;

2. Construction activities will only occur outside of the flood season (April 15 through October 31);

3. Construction equipment and materials will be stored, maintained, and refueled in designated staging areas as far away from suitable aquatic and riparian habitats as practicable;

4. A qualified NMFS-approved biologist will be present or on call during all construction and maintenance activities and will be responsible for overseeing compliance with protective measures for aquatic and terrestrial biological resources during clearing and work activities within and adjacent to areas that provide habitat for federally listed species. This includes ground-disturbing activities occurring in wet soils or adjacent to potential fish-bearing waters. The qualified biologist will ensure that all temporary barriers or exclusion fencing erected around construction areas are maintained and allow for fish species in the vicinity to move away from the construction area and activities on their own volition;

5. If an impact pile driver is necessary to construct the cofferdam in the wet, minimization measures would be implemented to reduce the underwater noise, such as placing a bubble curtain system underwater. This measure would also include underwater sound monitoring during impact pile-driving activities to minimize the potential for sound levels to exceed those that may adversely affect fish. Because both juvenile and adult life stages of fish species of focused evaluation may be present during pile driving in the Sacramento River, underwater noise thresholds to be applied include a peak level of 206 decibels (dB) and an accumulated SEL of 183 dB (FHWG 2008);

6. A Fish Rescue and Salvage Plan will be prepared and implemented prior to the commencement of construction activities and will only be applied during construction activities if needed. This Fish Rescue and Salvage Plan will stipulate that at least one NMFS-approved biologist will be on site to assist with fish relocation activities and ensure that cofferdam construction and removal procedures will be implemented using best management practices. A list of gear types to be employed during fish relocation activities (e.g., dip, seine, and fyke nets) will be included in the Fish Rescue and Salvage Plan;

7. A Spill Prevention, Control, and Countermeasure Plan (SPCCP) will be developed and implemented by Reclamation, DWR, or their contracted construction personnel. The SPCCP is designed to minimize the potential for, and effects from, spills of hazardous, toxic, and petroleum substances during construction and operations, and maintenance activities, as well as to minimize the effects of unearthing previously undocumented hazardous materials during excavation activities. The SPCCP will be completed prior to the commencement of construction activities. Implementation of this measure will comply with Federal and State water quality regulations. The SPCCP will describe spill sources and pathways in addition to the actions that will be taken in the event of a spill or the exposure of an undocumented hazard. The SPCCP will additionally outline descriptions of containment facilities and practices such as double-walled tanks,

containment berms, emergency shut-offs, drip pans, fueling procedures, and spill response kits. It will also describe how and when personnel are trained in the proper handling, spill prevention, and response procedures;

8. Prior to the commencement of construction and maintenance activities, Reclamation, DWR, or their contracted construction personnel will prepare a Stormwater Pollution and Prevention Plan (SWPPP) that describes best management practices that will be implemented to control accelerated erosion, sedimentation, and other pollutants during and after construction.

9. A sampling plan will be developed and implemented based on specific site conditions and in consultation and coordination with the Central Valley Regional Water Quality Control Board (CVRWQCB). Specifically, the *Basin Plan for the Sacramento River and San Joaquin River Basins* (Fourth Edition) (CVRWQCB 2016) contains turbidity objectives that stipulate where natural turbidity is between 5 and 50 nephelometric turbidity units (NTUs), turbidity levels may not be elevated by 20 percent above ambient conditions; where ambient conditions are between 50 and 100 NTUs, conditions may not be increased by more than 10 NTUs; and where natural turbidity is greater than 100 NTUs, increases will not exceed 10 percent. If turbidity limits exceed basin plan standards, construction-related earth-disturbing activities will slow to a point that will alleviate the problem until local conditions return to background levels; and,

10. Prior to the commencement of construction, operations, and maintenance activities, all personnel and contractors who will be on site during construction, operations, and maintenance will complete a mandatory worker environmental awareness training program conducted by a qualified biologist. Any new personnel or contractors that come onboard after the initiation of construction, operations, and maintenance activities will also be required to complete the mandatory worker environmental awareness training program before they begin working. The training will advise workers of potential impacts to federally listed species, suitable habitat for these species, and the potential penalties for impacts to such habitats or species. At a minimum, the program will include the following topics: occurrences of the federally listed species in the action area, physical description, life history, habitat requirements and timing, sensitivity to human activities, legal protection and penalties for violations of Federal laws, reporting requirements, work features designed to reduce the impacts, and general wildlife protection measures.

"Interrelated actions" are those that are part of a larger action and depend on the larger action for their justification. "Interdependent actions" are those that have no independent utility apart from the action under consideration (50 CFR 402.02). There are no interdependent or interrelated activities associated with the proposed Federal action.

2 ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

The ESA establishes a national program for conserving threatened and endangered species of fish, wildlife, plants, and the habitat upon which they depend. As required by section 7(a)(2) of the ESA, each Federal agency must ensure that its actions are not likely to jeopardize the continued existence of endangered or threatened species, or adversely modify or destroy their designated critical habitat. Per the requirements of the ESA, Federal action agencies consult with NMFS and section 7(b)(3) requires that, at the conclusion of consultation, NMFS provides a BO stating how the agency's actions would affect listed species and their critical habitats. If incidental take is reasonably certain to occur, section 7(b)(4) requires NMFS to provide an ITS that specifies the impact of any incidental taking and includes non-discretionary reasonable and prudent measures (RPMs) and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This BO includes both a jeopardy analysis and/or an adverse modification analysis. The jeopardy analysis relies upon the regulatory definition of "to jeopardize the continued existence of" a listed species, which is "to engage in an action that would be expected, directly or indirectly, to reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing the reproduction, numbers, or distribution of that species" (50 CFR 402.02). Therefore, the jeopardy analysis considers both survival and recovery of the species.

This BO relies on the definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat for the conservation of a listed species. Such alterations may include, but are not limited to, those that alter the physical or biological features essential to the conservation of a species or that preclude or significantly delay development of such features" (81 FR 7214, February 11, 2016).

The designations of critical habitat for some listed species use the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414, February 11, 2016) replace this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this BO, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

We use the following approach to determine whether the project is likely to jeopardize listed species or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat expected to be adversely affected by the project.
- Describe the environmental baseline in the action area.
- Analyze the effects of the project on both species and their habitat using an "exposure-response-risk" approach.
- Describe any cumulative effects in the action area.

- Integrate and synthesize the above factors by: (1) Reviewing the status of the species and critical habitat; and (2) adding the effects of the action, the environmental baseline, and cumulative effects to assess the risk that the project poses to species and critical habitat.
- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

2.2 Rangewide Status of the Species and Critical Habitat

This BO examines the status of each species that would be adversely affected by the project. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02. The BO also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the essential PBFs that help to form that conservation value. This BO analyzes the effects of the project on the following evolutionarily significant units (ESUs) and distinct population segments (DPS): the endangered Sacramento River (SR) winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), the threatened Central Valley (CV) spring-run Chinook salmon ESU (*O. tshawytscha*), California Central Valley (CCV) steelhead DPS (*O. mykiss*), and the Southern DPS (sDPS) North American Green Sturgeon (*Acipenser medirostris*). See Table 1 for species and Table 2 for critical habitat information.

Table 1. Description of species, current Endangered Species Act (ESA) listing classification and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Sacramento River winter-run Chinook salmon evolutionarily significant units (ESU; SR winter-run)	Endangered, 70 FR 37160; June 28, 2005 (Original listing – 59 FR 440; January 4, 1994)	According to NMFS (2016a) 5-year species status review, the status of SR winter-run has continued to decline since 2010. The extinction risk for the SR winter-run Chinook salmon ESU has increased from moderate risk to high risk of extinction since 2005, and several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence (NMFS 2016a). NMFS (2016a) concluded that the ESU classification as an endangered species is appropriate and should be maintained. During the 2012 to 2016 drought SR winter-run experienced increased water temperatures and low egg-to-fry survival (NMFS 2016a). In addition, recent adult returns have been low (1,546 individuals in 2016 and 975 individuals in 2017; CDFW 2018) likely due to impacts from the 2012 to 2016 drought.

Species	Listing Classification and Federal Register Notice	Status Summary
Central Valley spring-run Chinook salmon ESU (CV spring-run)	Threatened, 70 FR 37160; June 28, 2005 (Original listing – 64 FR 50394; September 16, 1999)	According to the NMFS (2016b) 5-year species status review, the status of the CV spring-run Chinook salmon ESU had improved since the 2011 5-year species status review (through 2014) due to extensive restoration and increases in spatial structure of historically extirpated populations (Battle and Clear creeks), which were trending in the positive direction. However, during the 2012 to 2016 drought, researchers observed high pre-spawn and egg mortality and uncertain juvenile survival, and since 2015, researchers have found many of the dependent populations in decline (NMFS 2016b). In 2017 CDFW reported the lowest CV spring-run escapement ever (CDFW 2018).
California Central Valley steelhead Distinct Population Segment (CCV steelhead)	Threatened, 71 FR 834; January 5, 2006 (Original listing – 63 FR 13347; March 19, 1998)	According to the NMFS (2016c) 5-year species status review, the status of CCV steelhead has changed little since the 2011 status review, which concluded that the DPS was likely to become endangered within the foreseeable future. Most populations of natural-origin CCV steelhead are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.
Southern DPS of North American green sturgeon (sDPS green sturgeon)	Threatened, 71 FR 17757; April, 7 2006	According to the NMFS (2015) 5-year species status review, some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers, but the species viability continues to be constrained by factors such as a small population size, lack of multiple spawning populations, and concentration of spawning sites into just a few locations. The species continues to face a moderate risk of extinction.

Table 2. Description of critical habitat, designation details, and status summary.

Species	Designation Date and Federal Register Notice	Status Summary
Sacramento River winter-run critical habitat (SR winter-run)	June 16, 1993; 58 FR 33212	Critical habitat for the SR winter-run Chinook salmon ESU was designated under the ESA on June 16, 1993 (58 FR 33212). Designated critical habitat includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Delta, all waters from Chipps Island westward to Carquinez Bridge, including Honker, Grizzly, and Suisun bays; Carquinez Strait, all waters of San Pablo Bay (west of the Carquinez Bridge), and all waters of San Francisco Bay (north of the San Francisco/Oakland Bay Bridge) from San Pablo Bay to the Golden Gate Bridge (59 FR 440). Critical habitat in the Sacramento River includes the river water column, river bottom, and adjacent riparian zone. Currently, many of the PBFs of SR winter-run Chinook salmon critical habitat are degraded and provide limited high quality habitat. Although the current conditions of SR winter-run Chinook salmon critical habitat are significantly limited and degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species.

Species	Designation Date and Federal Register Notice	Status Summary
Central Valley spring-run Chinook salmon critical habitat (CV spring-run)	September 2, 2005; 70 FR 52488	Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, the Yolo Bypass, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Currently, many of the PBFs of CV spring-run Chinook salmon critical habitat are degraded, and provide limited high quality habitat. Although the current conditions of CV spring-run Chinook salmon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain are considered to have high intrinsic value for the conservation of the species.
California Central Valley steelhead critical habitat (CCV steelhead)	September 2, 2005; 70 FR 52488	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba, and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, the Yolo Bypass, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. Many of the PBFs of CCV steelhead critical habitat are currently degraded and provide limited high quality habitat. Although the current conditions of CCV steelhead critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in the Sacramento/San Joaquin River watersheds and the Delta are considered to have high intrinsic value for the conservation of the species as they are critical to ongoing recovery effort.

Species	Designation Date and Federal Register Notice	Status Summary
Southern distinct population segment (sDPS) of North American green sturgeon (sDPS green sturgeon)	October 9, 2009; 74 FR 52300	Critical habitat includes the stream channels and waterways in the Delta to the ordinary high water line. Critical habitat also includes the mainstem Sacramento River upstream from the I Street Bridge to Keswick Dam (including the Sutter and Yolo bypasses and the lower American River confluence with the mainstem Sacramento River upstream to highway 160 bridge), the Feather River upstream to the fish barrier dam, and the Yuba River upstream to Daguerre Point Dam. Coastal bays and estuaries in California (San Francisco Bay, Suisun Bay, San Pablo Bay, and Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) as well as the lower Columbia River estuary are also included as critical habitat for sDPS green sturgeon. Coastal marine areas include waters out to a depth of 60 fathoms from Monterey Bay in California to the Strait of Juan de Fuca in Washington. Currently, many of the PBFs of sDPS green sturgeon are degraded and provide limited high quality habitat. Although the current conditions of green sturgeon critical habitat are significantly degraded, the spawning habitat, migratory corridors, and rearing habitat that remain in both the Sacramento/San Joaquin River watersheds, the Delta, and nearshore coastal areas are considered to have high intrinsic value for the conservation of the species.

2.2.1 *Recovery Plans*

In July 2014, NMFS released a final Recovery Plan for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (NMFS 2014, Recovery Plan). The Recovery Plan outlines actions to restore habitat, access, and improve water quality and quantity conditions in the Sacramento River to promote the recovery of listed salmonids. Key actions for the Recovery Plan include conducting landscape-scale restoration throughout the Delta, incorporating ecosystem restoration into Central Valley flood control plans that includes breaching and setting back levees, and restoring flows throughout the Sacramento and San Joaquin River basins and the Delta.

In August 2018, NMFS released a final Recovery Plan for the sDPS green sturgeon (NMFS 2018), which focuses on fish screening and passage projects, floodplain and river restoration, and riparian habitat protection in the Sacramento River Basin, the Delta, San Francisco Estuary, and nearshore coastal marine environment as strategies for recovery.

2.2.2 *Global Climate Change*

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley (CV) and aquatic habitat at large is climate change. Warmer temperatures associated with climate change reduce snowpack and alter the seasonality and volume of seasonal hydrograph patterns (Cohen *et al.* 2000); Central California has shown trends toward warmer winters since the 1940s (Dettinger and Cayan 1995). Projected warming is expected to affect CV Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any CV Chinook salmon populations can persist (Williams 2006).

SR winter-run Chinook salmon embryonic and larval life stages that are most vulnerable to warmer water temperatures occur during the summer, which makes the species particularly at risk from climate warming. The only remaining population of SR winter-run Chinook salmon relies on the cold water pool in Shasta Reservoir, which buffers the effects of warm temperatures in most years. The exception occurs during drought years, which are predicted to occur more often with climate change (Yates *et al.* 2008). The long-term projection of how the Central Valley Project (CVP) and State Water Project (SWP) will operate incorporates the effects of climate change in three possible forms: less total precipitation; a shift to more precipitation in the form of rain rather than snow; or, earlier spring snow melt (Reclamation 2008). Additionally, air temperature appears to be increasing at a greater rate than what was previously analyzed (Lindley 2008, Beechie *et al.* 2012, Dimacali 2013). These factors will compromise the quantity and/or quality of SR winter-run Chinook salmon habitat available downstream of Keswick Dam. It is imperative for additional populations of SR winter-run Chinook salmon to be re-established into historical habitat in Battle Creek and above Shasta Dam for long-term viability of the ESU (NMFS 2014).

CV spring-run Chinook salmon adults are vulnerable to climate change because they oversummer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). CV spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change.

CCV steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile CCV steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile CCV steelhead, which range from 14°C to 19°C (57°F to 66°F).

The Anderson Cottonwood Irrigation District (ACID) Dam is considered the upriver extent of sDPS green sturgeon passage in the Sacramento River. The upriver extent of sDPS green

sturgeon spawning, however, is approximately 19 miles downriver of the ACID Dam where water temperature is warmer than at the ACID Dam during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to the ACID Dam may remain within tolerable levels for the embryonic and larval life stages of sDPS green sturgeon, but temperatures at spawning locations lower in the river may be more affected.

In summary, observed and predicted climate change effects are generally detrimental to these listed species (McClure 2011, Wade *et al.* 2013), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While the uncertainty associated with these projections increases over time, the direction of climate change is relatively certain (McClure 2011).

2.3 Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02). The action area for the project includes all areas immediately impacted by construction, areas subject to clearing and grading, and areas affected by operations, which includes areas affected by the altered flow regime into and within the Yolo Bypass (Figure 1). Construction will be concentrated at the north end of the Yolo Bypass at the Fremont Weir and on the Sacramento River near River Mile (RM) 83. The construction of the headworks gate structure on the Fremont Weir will alter flows into the Yolo Bypass from the Sacramento River. Water levels and the timing of inundation would be affected by project operations throughout the Yolo Bypass from the Fremont Weir south to Liberty Island. Operations will divert water from the Sacramento River into the Yolo Bypass, thereby reducing the flows in the river. Therefore, the action area not only includes the entirety of the Yolo Bypass, but also the Sacramento River from RM 83 downstream to RM 79 just below its confluence with the Feather River. This action area includes areas in Solano, Sutter, and Yolo counties.

2.4 Environmental Baseline

The "environmental baseline" includes the past and present impacts of all Federal, state, or private actions and other human activities in the action area, the anticipated impacts of all proposed Federal projects in the action area that have already undergone formal or early section 7 consultation, and the impact of state or private actions which are contemporaneous with the consultation in process (50 CFR 402.02).

2.4.1 *Sacramento River*

The segment of the Sacramento River located within the action area is heavily channelized and leveed. The river is bordered by agricultural land and the City of Sacramento and surrounding areas. This segment of the Sacramento River is characterized primarily by slow-water glides and pools, is depositional in nature, and has lower water clarity and habitat diversity relative to the upper portion of the river. Over 30 fish species are known to occur within the Sacramento River. Many of these are anadromous, including both native and non-native species. Anadromous fish species include Chinook salmon (SR winter-run, CV spring-run, fall-run, and late fall-run

Chinook salmon), CCV steelhead, sDPS green sturgeon, white sturgeon, Pacific lamprey, river lamprey, American shad, and striped bass. Downstream from the City of Red Bluff, the Sacramento River provides a migration corridor and rearing habitat for salmonids and green sturgeon as well as spawning and rearing habitat for a variety of other native fish species such as Sacramento splittail and Sacramento pikeminnow.

2.4.2 *Yolo Bypass*

The Yolo Bypass can be divided into two main geographical sections. The northern portion of the Yolo Bypass is non-tidal, is boarded on the east by the Tule Canal (the upper extension of the Toe Drain), and bordered to the west by the west bypass levee (Figure 1). The southern portion of the Yolo Bypass enters into the Sacramento–San Joaquin Delta and has some tidally-influenced areas. Tidal conditions are routinely measured as far upstream in the Toe Drain as the I-80 causeway. The primary function of the Yolo Bypass is flood protection for the city of Sacramento. The Yolo Bypass also consists of the Yolo Bypass Wildlife Area (YBWA), privately-owned farmlands, and recreational areas, all of which are subject to flood flow conveyance easements that restrict development.

The Yolo Bypass supports multiple aquatic habitats, including stream and slough channels, as well as flooded shallow water. From November to April, if the bypass is inundated, CV spring-run and SR winter-run Chinook salmon use these diverse habitats for migration and rearing (CALFED 2000, Reclamation and DWR 2012). The Yolo Bypass floods to some extent about 70 percent of all water years. The Yolo Bypass has flooded as early as October and as late as June, but the typical period of inundation is in January to March (CALFED 2000, Sommer *et al*. 2001a). The entire Yolo Bypass is considered to be floodplain habitat when inundated.

The Yolo Bypass is an important migratory pathway for downstream migrating Chinook salmon, CCV steelhead, and other native, anadromous fish. Currently, the Yolo Bypass is the largest contiguous floodplain in the Central Valley still experiencing long-duration flooding in the spring; this spring inundation period provides the greatest benefit for native fish production in the Central Valley (Williams *et al*. 2009). Sommer *et al.* (2001a) found that seasonal floodplain habitat within the Yolo Bypass also provided better rearing conditions for outmigrating anadromous salmonids than nearby Sacramento River sites because of the increased area, the complexity of suitable habitat, and the increased food resources. This study concluded that these conditions allowed juvenile Chinook salmon to grow substantially larger in the Yolo Bypass, primarily because of a greater abundance of invertebrate prey in the inundated floodplain (Sommer *et al*. 2001a). Results from a similar study of juvenile Chinook reared directly on a rice field in the Yolo Bypass demonstrated that experimental inundation of fields during winter can create productive aquatic food webs, and agreed with previous findings that rearing in off-channel habitat results in rapid growth for juvenile Chinook salmon (Katz 2012; Katz *et al.* 2013).

When flooded, the Yolo Bypass provides up to about 24,000 hectares (59,300 acres) of shallow floodplain habitat, ranging from 2 to 10 km (about 1.2 to 6 miles) wide over its 64-km (about 40-mile) length and has a typical mean depth of 2 m (6.5 feet) or less (Sommer *et al.* 2008). Seasonal inundation of the Yolo Bypass leads to an increase in phytoplankton and other food resources that support fish species residing in the floodplain and provides a source of these food

resources to downstream habitats (Sommer *et al.* 2001b). Generally, longer inundation events allow for greater juvenile salmon food production and, as a result, provide greater benefits to fish species than shorter events (Reclamation and DWR 2012). However, short events may provide ecological benefits for many endangered and threatened fish species (Sommer *et al.* 2004).

Under current conditions, most juvenile Chinook salmon access the Yolo Bypass floodplain following an overtopping event at the Fremont Weir, but the Yolo Bypass also provides important rearing habitat for juvenile salmonids during dry periods and drought years in addition to periods of inundation. The southern end of the Yolo Bypass is tidally influenced, and in some conditions, fish can use these tidally-influenced areas for rearing but there are several fish passage barriers that prevent fish from using the entire Yolo Bypass unless it is under flood conditions. In addition, the Yolo Bypass is inundated by several tributaries that allow a significant amount of water onto the bypass independent of the flooding at Fremont Weir. During 2014, Goertler *et al.* (2015) found that despite the lack of flooding during an extreme drought, a relatively high number of juvenile Chinook salmon were found occupying the Yolo Bypass. Based on drift invertebrates and zooplankton sampling in the Toe Drain, the Yolo Bypass may have been the most productive habitat available to juvenile Chinook salmon outmigrating from the Sacramento River during the 2012-2015 drought (Goertler *et al.* 2015). Although water temperatures were elevated in the Yolo Bypass, higher food levels may have allowed juvenile Chinook salmon to continue to rear there. In addition, the Yolo Bypass has more natural banks and riparian vegetation than the Sacramento River, and is better connected to tidal wetlands than the Sacramento River (Goertler *et al.* 2015).

The action area is considered an important rearing and migratory corridor for all ESA-listed anadromous fish species. Upstream migrating adult sDPS green sturgeon and salmonids arrive in the northern Yolo Bypass during Fremont Weir overtopping events. Juvenile salmonids and sDPS green sturgeon may enter the Yolo Bypass if their migration down the Sacramento River coincides with a Fremont Weir overtopping event. Both adults and juveniles have the potential to be stranded in the stilling basin of the Fremont Weir and in nearby scour channels and ponds as floodwaters recede following overtopping events. Listed fish trapped in the shallow waters of the stilling basin and scour channels are vulnerable to poaching, poor water quality, and falling water levels, unless they pass through the Fremont Weir adult fish passage structure.

It is also likely that adult salmonids are susceptible to straying into the Yolo Bypass as agricultural drainage increases through the Yolo Bypass during periods of low flow in the Sacramento River. These agricultural releases act as attraction flows that cause upstream migrating adults to stray into the Yolo Bypass while in the Cache Slough Complex south of the Yolo Bypass. During low flow periods, fish passage connectivity to the Sacramento River at Fremont Weir is compromised, which contributes to stranding in this area. In addition, adult salmonids and sturgeon may experience delays if they encounter agricultural road crossing 1 or 4 in the Tule Canal at lower flows, when these agricultural crossings may not be submerged. The agricultural road crossings become submerged during higher flow conditions, such as when Fremont Weir overtops, eventually allowing salmonids or sturgeon to move beyond them. Adult or juvenile migratory fish, including salmonids and sturgeon, may become trapped in between these crossings as higher flows recede.

Baseline and cumulative effects from activities such as continued agricultural practices, bank stabilization projects, and recreational boating and fishing will continue to negatively affect the federally listed species in the action area. Runoff from agricultural activities may contain contaminants such as pesticides, sediments, and nutrients that may affect listed species through lethal and sublethal impacts. Levee construction and bank protection can reduce floodplain connectivity, change substrate size, and decrease riparian habitat and shaded riverine aquatic cover. However, NMFS expects the species and their designated critical habitats to improve with the implementation of CVP/SWP long-term operations biological opinion RPA actions I.6 and I.7 and recovery actions identified in NMFS (2014, 2018).

2.4.3 *Status of Listed Species and Critical Habitat in the Action Area*

2.4.3.1 Sacramento River Winter-run Chinook Salmon

Adult SR winter-run Chinook salmon migration through the action area occurs from mid-November through May (DWR 2017). Adult SR winter-run Chinook salmon enter the Yolo Bypass from the south, often straying from the adjoining Sacramento River in response to tidal exchange or substantial flow pulses coming from the Yolo Bypass. Juvenile SR winter-run Chinook salmon passing Knights Landing upstream of the action area occur primarily from November through March and peak during December, with some emigration continuing through May in some years (Snider and Titus 2000). Currently, most juvenile SR winter-run Chinook salmon access the Yolo Bypass floodplain following an overtopping event at the Fremont Weir.

Critical habitat for SR winter-run Chinook salmon is designated in the Sacramento River. The PBFs include freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of habitat in the action area are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. Currently, the PBFs of SR winter-run Chinook salmon critical habitat in the Sacramento River are degraded and provide limited high quality habitat. Although the current conditions of SR winter-run Chinook salmon critical habitat in the Sacramento River are significantly limited and degraded, the habitat remaining is considered highly valuable.

Although the Yolo Bypass is not designated critical habitat for SR winter-run Chinook salmon, NMFS recognizes that it may be used when inundated with Sacramento River flood flows and is an important rearing habitat for juvenile SR winter-run Chinook salmon.

2.4.3.2 Central Valley Spring-run Chinook Salmon

Adult CV spring-run Chinook salmon may be in the Sacramento River near the Fremont Weir or the Yolo Bypass from January through May (DWR 2017). Juvenile CV spring-run Chinook salmon passing Knights Landing upstream of the action area occur primarily from November through May and peak during December. In most years, juvenile CV spring-run Chinook salmon have a second peak from March through April (NMFS 2009). Currently, most juvenile CV spring-run Chinook salmon access the Yolo Bypass floodplain following an overtopping event at the Fremont Weir.

Critical habitat for CV spring-run Chinook salmon is designated in the Sacramento River and Yolo Bypass. The PBFs include freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of habitat in the action area are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. Currently, the PBFs of CV spring-run Chinook salmon critical habitat in the Sacramento River and Yolo Bypass are degraded and provide limited high quality habitat. Although the current conditions of CV spring-run Chinook salmon critical habitat in the Sacramento River and Yolo Bypass are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.4.3.3 California Central Valley Steelhead

Adult and juvenile CCV steelhead can be present in the Yolo Bypass year-round, although their presence often coincides with high flow events during the fall through spring. Adult CCV steelhead presence near the Fremont Weir peaks in early October and extends through March (DWR 2017). Adults have been observed during Yolo Bypass fyke trap monitoring from October through April, with peak occurrence in January and February (Reclamation and DWR 2017). Juvenile CCV steelhead passing Knights Landing upstream of the action area occur primarily from January through May and peak during March and April (Snider and Titus 2000, McEwan 2001). Most juvenile CCV steelhead access the Yolo Bypass floodplain following an overtopping event at the Fremont Weir. Juvenile CCV steelhead have been observed in Yolo Bypass RST sampling efforts from January through June, with peak presence occurring in March (Reclamation and DWR 2017). California Department of Fish and Wildlife (CDFW) stranding surveys in northern Yolo Bypass scour pools and swales found that juvenile CCV steelhead was the most abundant fish species encountered in 2017 (CDFW 2017). In general, CCV steelhead are not commonly captured in the Yolo Bypass, and the majority of the catch has been dominated by juveniles (Reclamation and DWR 2017). Only 10 adult CCV steelhead were captured from 2001 through 2009, based on data from fyke trap operations in the Toe Drain in the Yolo Bypass (DWR, unpublished data). No adult CCV steelhead were captured by CDFW during Fremont Weir fish rescue efforts until May 2017 when two adult CCV steelhead were captured after an overtopping event at the Fremont Weir.

Critical habitat for CCV steelhead is designated in the Sacramento River and Yolo Bypass. The PBFs include freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of habitat in the action area are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults. Currently, the PBFs of CCV steelhead critical habitat in the Sacramento River and Yolo Bypass are degraded and provide limited high quality habitat. Although the current conditions of CCV steelhead critical habitat in the Sacramento River are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.4.3.4 Southern Distinct Population Segment of North American Green Sturgeon

Adult sDPS green sturgeon may occur in the action area from February through April, with some adults migrating up the nearby Sacramento River as late as July (Heublein et al. 2009). During flood flows in the Sacramento River system, upstream migrating adult sDPS green sturgeon are attracted by the high flows in the Yolo and Sutter bypasses. Adults that move into the Yolo Bypass can eventually concentrate behind the Fremont weir, where the fish are blocked from further upstream migration. DWR recently completed the Fremont Weir Adult Fish Passage Modification Project which allows some adult sturgeon and salmonids to volitionally enter the Sacramento River from the Yolo Bypass after an over topping event, but because the Fremont Weir is not graded to drain into the new fish passage, some fish will remain stranded behind the weir. Agency biologists will continue to conduct rescues when fish become stranded behind the weirs (CDFW 2011). Recurring stranding events might have significant population-level impacts on sDPS green sturgeon (Thomas *et al.* 2013). Adult sDPS green sturgeon have also been observed and rescued in Tule Pond following overtopping events at the Fremont Weir (CDFW 2016). These stranded fish may have attempted to migrate upstream on the tail end of an overtopping event at the Fremont Weir, or they successfully made it to the Fremont Weir but were unable to ascend the weir and retreated to Tule Pond.

Although sDPS green sturgeon have been stranded and rescued in the Yolo Bypass after overtopping events at the Fremont Weir, adult green sturgeon have never been observed in the fyke trap operations in the Toe Drain of the Yolo Bypass (Reclamation and DWR 2017). Juvenile sDPS green sturgeon have been caught in the Sacramento River from May through August (NMFS 2018), and juveniles may also be present in the Yolo Bypass from May through August (CDFG 2002).

The Yolo Bypass and the Sacramento River are designated critical habitat for sDPS green sturgeon. PBFs for sDPS green sturgeon within freshwater riverine systems include food resources, substrate type/size, flow, water quality, migration corridors free of passage impediments, depth (holding pools), and sediment quality. NMFS recognizes that when inundated with Sacramento River flood flows, Yolo Bypass is an important rearing habitat for juvenile sDPS green sturgeon. PBFs for critical habitat in the action area have been severely impaired and degraded; but the habitat remaining is of high value due to the limited amount of sDPS green sturgeon habitat in total.

2.5 Effects of the Action

Under the ESA, "effects of the action" means the direct and indirect effects of an action on the species or critical habitat, together with the effects of other activities that are interrelated or interdependent with that action, that will be added to the environmental baseline (50 CFR 402.02). Indirect effects are those that are caused by the project and are later in time, but still are reasonably certain to occur.

2.5.1 ***Effects to Species***

Based on the salvage data from the CVP and SWP facilities from 1999 to the present available on Reclamation's Central Valley Operations web site (http://www.usbr.gov/mp/cvo/), NMFS

expects individual SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon to be present in the action area during the proposed construction and operation of the facilities.

2.5.2 *Construction-Related Effects*

Construction of the structures, channels, and facilities associated with the project will require substantial excavation, earth moving, and rock and gravel placement in the Sacramento River, the Yolo Bypass, and the Tule Canal during a period of time when juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon are migrating down the Sacramento River and through the action area. The excavation and placement of rock below the waterline will produce noise and physical disturbance, which could displace juvenile and adult fish into adjacent habitats, or crush and injure, or kill, individuals. Similarly, construction activities carried out in close proximity to the river channel have the potential to transfer kinetic energy through the adjoining substrates and disturb the water column and temporarily generate increased turbulence and turbidity in the river. Migrating juveniles react to this disturbance with a startle response in which they are likely to suddenly disperse in random directions (Carlson *et al.* 2001). This displacement can lead them into predator-occupied habitat where opportunistic predators can take advantage of behavioral changes to target and prey on juvenile salmonids. Carlson *et al.* (2001) observed this behavior occurring in response to routine channel maintenance activities in the Columbia River. Some of the fish that did not immediately recover from the disorientation of turbidity and noise from channel dredges and pile driving swam directly into the point of contact with predators.

Construction activities are also expected to generate underwater noise from both terrestrial and in-water sources, occasionally reaching intense levels. Heavy earthmoving equipment will be used on river banks and levees to transport large quantities of material needed for channel modifications and facility construction. These activities, including metal components (buckets, scoops, etc.) striking rock, will generate and propagate sharp, transient noises into the water column as coupled noise, which will travel through the underlying substrate. Intense noise will also be produced in the aquatic environment by front loaders, excavators, and dump trucks operating in close proximity to the river. Feist *et al.* (1992) found that noise from pile driving activities in Puget Sound affected the general behavior of juvenile salmon by temporarily displacing them from active construction areas. Nearly twice as many fish were observed at construction sites on non-pile driving days compared to days when pile driving occurred. However, portions of the action area including the Sacramento River in the vicinity of the Fremont Weir may have more restrictive channel widths (<328 ft), making it difficult or impossible to completely avoid construction-related disturbances. Burgess and Blackwell (2003) observed that vibratory installation of a sheet pile wall in an upland position generated sound levels of approximately 140 decibels (re: 1 µpascal [1µPa]) in an adjacent waterway at a distance of 200 feet, indicating that noise will transmit through soil into the water column. Based on recent acoustic monitoring results from other DWR projects, the level of noise generated during construction activities generally ranged between 110 and 150 decibels, and is therefore not expected to reach levels that will incur tissue injury (>207 decibels peak, referenced to 1µPa), but the level of noise is likely to cause altered behavioral responses [>150 decibels root mean square (dBrms), re: 1µPa] of fish swimming within 300 feet of the source of the acoustic signal. Construction-related disturbances will only occur during daylight hours. The repetitive frequency

of the disturbance is measured on the order of half a minute (excavator) to several minutes (dump trucks and front loaders), which reduces the risk of accumulated sound levels as experienced during pile driving activities when repetitive frequency is measured on the order of a few seconds between strikes.

NMFS expects both juvenile and adult life stages of fish to be at some risk of exposure to the construction activity. Typically, smaller fry- and larval-sized fish would have the highest potential risk of exposure due to their near shore orientation and slower swimming speeds. However, fry- and larval-sized fish are unlikely to be present in the construction area due to the season and the location of action area, which is downstream of the natal reaches of CCV steelhead, sDPS green sturgeon, and Chinook salmon. NMFS generally expects most migrating fish to avoid entering the site of active construction activity, or to have a startle response when construction activity begins. Although behavioral reactions of fish to in-water disturbances vary greatly between species, many studies have also demonstrated that avoidance behavior is not limited to a simple startle response, but that directional changes and shifting stratification within the water column also exhibit deflective movement directly in response to, and away from, the source signal in an attempt to selectively avoid the disturbance (Shafiei Sabet *et al.* 2015). These behavioral modifications may delay migration for several hours or more. When construction activity is curtailed or paused, such as when crews take breaks or suspend activities overnight, fish are generally expected to continue their migration. Migratory movement is generally thought to occur under low light conditions, which is when construction activity would not be occurring. However, individual fish may mobilize at any time and, thus, face a higher level of risk of exposure to construction-related effects.

Proposed construction and earthmoving activities associated with the project will disturb local soils and the underlying riverbed, potentially resulting in increased erosion, siltation, and sedimentation. Highly elevated suspended sediments can negatively affect salmonids in the area by obstructing sensitive gill structures (Nightingale and Simenstad 2001), but these effects are generally confined to turbidity levels in excess of 4,000 mg/L. Based on the best available information, including measured turbidity increases during similar construction projects in previous years, NMFS does not anticipate that turbidity levels associated with the project will reach these deleterious levels. During the construction of recent similar actions, measurements of turbidity 328 feet downstream from the construction activity rarely exceeded 15 Nephelometric Turbidity Units (NTUs), and, even then, those observed exceedances were never in succession, indicating these incidences were always short in duration and small in scale when they occurred, and is expected to be the same during construction of the proposed action as well. However, responses of salmonids to elevated levels of suspended sediments often fall into three major categories: physiological effects, behavioral effects, and habitat effects (Bash *et al.* 2001). The severity of the effect is a function of concentration and duration (Newcombe and MacDonald 1991, Newcombe and Jensen 1996). Low concentrations and long exposure periods are frequently as deleterious as short exposures to high concentrations of suspended sediments. A review by Lloyd (1987) indicated that several behavioral characteristics of salmonids can be altered by even relatively small changes in turbidity (10 to 50 NTUs). Salmonids exposed to slight to moderate increases in turbidity exhibited avoidance, loss of station in the stream, reduced feeding rates, and reduced use of overhead cover. Short-term increases in turbidity and suspended sediment may disrupt feeding activities of fish or result in temporary displacement

from preferred habitats. Numerous studies show that suspended sediment and turbidity levels moderately elevated above natural background values can result in non-lethal detrimental effects to salmonids, for example, decreasing reproductive success, reducing feeding success and growth, causing avoidance of rearing habitats, and disrupting migration cues (Bash *et al.* 2001). Sigler *et al.* (1984) found that prolonged turbidity between 25 and 50 NTUs reduced growth of juvenile Coho salmon and steelhead. Newcombe and MacDonald (1991) found that the ability of salmon to find and capture food was impaired at turbidities from 25 to 70 NTUs. Reaction distances of rainbow trout to prey were reduced with increases of turbidity of only 15 NTUs over an ambient level of 4 to 6 NTUs in experimental stream channels (Barrett *et al.* 1992). Bisson and Bilby (1982) reported that juvenile Coho salmon avoided turbidities exceeding 70 NTUs.

NMFS expects turbidity to affect Chinook salmon and CCV steelhead in much the same way that it affects the other salmonids used in these studies because of similar physiological and life history requirements between species. The disturbance of the channel banks and bottom at each of the project areas during construction will increase suspended sediments locally, which will produce turbidity plumes that will extend downstream from the construction activity. The duration of turbidity plumes resulting from in-water construction-related activities is expected to last several hours more after the work has ceased, when the turbidity returns to background levels. Following the proposed schedule, the longest continuous construction activity is anticipated to be 7 months, which will occur at the site of the new headworks fish passage structure on the Fremont Weir in the Yolo Bypass where it connects to the Sacramento River. Individual fish are not expected to face continuous exposure to construction-related effects for the entire 7-month construction period, however, as they will be migrating through the area. Migrating adult and juvenile fish are expected to move through, rather than hold position or remain in the immediate vicinity of ongoing construction activities for more than a few hours or days. Although Chinook salmon and CCV steelhead are highly migratory and capable of moving freely throughout the action area, a substantial increase in turbidity may injure fish by temporarily disrupting normal behaviors that are essential to growth and survival, such as feeding, sheltering, and migrating. Disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss resulting in harm to individuals and increased risk to the affected species. Turbidity increases may also affect the sheltering abilities of some fish and may decrease their likelihood of survival by increasing their susceptibility to predation. Conversely, some turbidity is helpful in reducing predation by shielding individual fish from visual predators in a turbid field (Gregory and Levings 1998).

Based on similar projects conducted by DWR and the U.S. Army Corps of Engineers (i.e., levee repair work and placement of rock riprap), construction activities are expected to result in periodic increases in localized turbidity levels up to 75 NTUs. These levels are capable of affecting normal feeding and sheltering behavior. In the past, levee protection work on the Sacramento River has produced turbidity plumes that hug the shoreline for several hundred feet downstream of the activity, and work on and around the Fremont Weir may produce turbidity plumes that exhibit a similar expression. However, once construction stops, water quality is expected to return to background levels within a few hours, depending on how high the percentage of fines in the material are. Adherence to erosion control measures and best management practices (BMP), such as the use of silt fences, straw bales, and straw wattles, will

minimize the amount of sediment from construction activities and will minimize the potential for post-construction turbidity changes should precipitation events occur after construction has been completed. NMFS expects that most fish will actively avoid the elevated turbidity plumes if possible. For those fish that do not or cannot avoid the turbid water, exposure is expected to be brief (i.e., minutes to hours) and not likely to cause injury or death from reduced growth or physiological stress. This expectation is based on the general avoidance behaviors of salmonids and the requirement to suspend construction when turbidity exceeds CVRWQCB standards. However, some juveniles that are exposed to turbidity plumes may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish migrate past the turbid water, normal feeding and migration behaviors are expected to resume.

2.5.3 *Operations and Maintenance-Related Effects*

Operation of the new headworks fish passage structure will provide improved hydrologic connectivity for ESA-listed fish species migrating between the Sacramento River and the Yolo Bypass. This enhanced connectivity is expected to considerably improve habitat conditions in the bypass, greatly reduce stranding events below the Fremont Weir, and enhanced connectivity should contribute to increased individual survival as well as likely increasing spawning success upstream of the Yolo Bypass. In addition, enhanced hydrologic connectivity between the bypass and the river is anticipated to reduce the necessity and frequency of non-project-related fish rescue efforts (by CDFW) below the weir as well as the susceptibility of listed fish to both poaching and predation in the Yolo Bypass. The modifications at Agricultural Road Crossing 1, will improve hydrologic connectivity of habitats within the Yolo Bypass between the Tule Canal and Tule Pond, thereby enhancing the opportunities for adult listed fish species migrating into and through the bypass to return to the Sacramento River.

Operation of the new headworks fish passage structure will coincide with Fremont Weir overtopping events between November 1 and March 15 every year. Upstream migrating adults have the potential to become injured or killed as a result of being trapped and crushed under the bottom-hinged gates in the passage structure. However, the bottom-hinged gates are designed to be raised and lowered by hydraulic cylinders, which take roughly 60 minutes to fully close, providing fish with ample time to get out of the gate's path of travel. The hydraulic cylinders will operate on fluids designated as environmentally accepted lubricants that are plant-based and biodegradable, minimizing the potential for diminished water quality due to malfunctioning or leaking equipment. Due to the high unlikelihood of occurrence, impacts to listed fish are not expected to occur.

Maintenance activities, including debris, vegetation, and sediment removal associated with project facilities and improvements, as well as maintenance activities associated with the operation of the new fish passage structure, will be conducted between April 16 and October 31, which is outside of the flood season. During this time period, listed species are not expected to be present in the Yolo Bypass floodplain, and high temperatures accompanied by low dissolved oxygen concentrations are common in the Tule Canal. These planned maintenance activities coincide with a period of time when listed fish species are not expected to be present.

2.5.4 *Effects to Critical Habitat*

In-water construction activities have the potential to temporarily negatively affect the PBFs of migratory corridors and rearing habitat in the Sacramento River and Yolo Bypass adjacent to the construction sites, for all listed anadromous fish. This includes increased exposure to noise, turbidity, and suspended sediments. Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton, and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987, Newcombe and MacDonald 1991). Reduction in prey/food for anadromous fish may result in short term localized degradation of the rearing habitat PBFs. However, these effects on critical habitat would be minimized by implementing various BMPs and conservation measures such as implementing spill and stormwater prevention plans, implementing a turbidity monitoring plan, complying with the CVRWQCB turbidity objectives, and not performing any work during the flood season or overtopping events. Construction-related increases in turbidity and suspended sediments into the Sacramento River will be minimal, as they are expected to be temporary, brief, and localized. Construction-related increases in turbidity and suspended sediments into the Yolo Bypass will be minimal, as they are expected to be temporary, brief, and localized; construction will also be completed outside of the flood season.

In addition, the project will result in the permanent replacement of natural substrate with rock revetment and artificial substrates in the engineered channels associated with project structures and improvements in the Yolo Bypass. The permanent conversion of natural substrates to artificial engineered substrates will reduce the quality of rearing habitat in that footprint of the structures, resulting in reduced productivity of invertebrates and other prey items in the bypass, potentially contributing to reduced growth, fitness, and survival of sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon utilizing this area for rearing habitat. However, improved access to the expansive floodplain in the Yolo Bypass is expected to greatly outweigh the permanent impacts of the structures resulting in overall benefits to rearing habitat PBFs.

Following construction, operation of the gates from November 1 through March 15 will diminish flows in the Sacramento River downstream from the intake channel, where up to 6,000 cfs would enter the Yolo Bypass and flow south towards Tule Canal. Diminished flows may result in increased competition for food, cover, and available habitat, and a higher probability of encountering a predator in the reaches of the Sacramento River immediately downstream from the intake channel where it would divert flow onto the Yolo Bypass. Those effects would negatively affect the migratory habitat PBFs of salmonid and sturgeon designated critical habitats in the Sacramento River. The extent of this effect would be minimized by the fact that operation of the gates is entirely dependent on river stage, and no more than 13% of the total volume of the Sacramento River would be entrained onto the Yolo Bypass when it is operating at its maximum diversion rate of 6,000 cfs. In addition, NMFS anticipates the severity of the impact to the migratory corridor PBFs in the Sacramento River would largely be balanced out by the beneficial effects of enhanced habitat connectivity and rearing potential expected to be realized on the PBFs in the Yolo Bypass when the project would be operating.

Construction associated with improvements in the Yolo Bypass has the potential to result in the short term degradation of the migratory corridor and rearing habitat PBFs of sDPS green

sturgeon, CCV steelhead, and CV spring-run Chinook salmon critical habitat by reducing prey availability. These effects would be extremely limited since all construction work and routine maintenance activities in the bypass would be conducted in dry conditions during the non-flood season when the area is hydrologically disconnected from the Sacramento River. After construction in the bypass is complete, the condition and quality of the migratory corridors and rearing habitat PBFs of sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon designated critical habitat is expected to rapidly revert to pre-project conditions, including recolonization of invertebrates and the restoration of functional ecological processes. Furthermore, operation and maintenance of the project-related facilities and structures are expected to improve habitat connectivity and productivity in the bypass. This is anticipated to reduce stranding and allow greater access to the inundated floodplain, thereby conferring long-term benefits to the designated critical habitats for sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon by improving the PBFs of both freshwater rearing sites for juveniles and freshwater migration corridors for all life stages of sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon utilizing both the Yolo Bypass and the Sacramento River.

Although the Yolo Bypass has not been designated as critical habitat for SR winter-run, an increasingly large proportion of Sacramento River Basin salmonids are expected to utilize the bypass as a migration corridor and for rearing habitat following construction and operation of the new facilities, and are expected to greatly benefit as a result.

2.6 Cumulative Effects

"Cumulative effects" are those effects of future state or private activities, not involving Federal activities, that are reasonably certain to occur within the action area of the Federal action subject to consultation (50 CFR 402.02). Future Federal actions that are unrelated to the project are not considered in this section because they require separate consultation pursuant to section 7 of the ESA.

Some continuing non-Federal activities are reasonably certain to contribute to climate effects within the action area. However, it is difficult if not impossible to distinguish between the action area's future environmental conditions caused by global climate change that are properly part of the environmental baseline *vs.* cumulative effects. Therefore, all relevant future climate-related environmental conditions in the action area are described in the environmental baseline (Section 2.4).

Non-Federal actions that occur in the action area include ongoing agricultural activities and increased urbanization. Agricultural practices throughout the Yolo Bypass may negatively affect riparian and wetland habitats. Unscreened agricultural diversions along the Sacramento River entrain fish, including juvenile salmonids and sDPS green sturgeon. Grazing activities from dairy and cattle operations can degrade or reduce suitable critical habitat for listed salmonids and sturgeon by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the Sacramento River, the Yolo Bypass, and the Delta. Stormwater and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may negatively affect salmonid and sturgeon reproductive success and survival rates (Dubrovsky *et al*. 1998, Daughton 2003).

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased anthropogenic growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS. Increased urbanization is also expected to result in an expansion of increased recreational activities throughout the action area. Among the activities expected to increase in both volume and frequency is recreational boating, which typically results in greater increased wave action and propeller wash in waterways. These activities will potentially degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity in hydrologically connected waters. Wakes and propeller wash also disturb benthic sediments and, thereby, potentially re-suspend contaminated sediments and further degrading areas of submerged vegetation. This disturbance, in turn, would reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and sDPS green sturgeon entering and moving throughout the action area. Expanded recreational boat operation is also expected to result in elevated concentrations of contaminants from the operation of gasoline and diesel powered engines on watercraft entering the streams and waterways of the action area, including the Sacramento River.

2.7 Integration and Synthesis

The Integration and Synthesis section is the final step in our assessment of the risk posed to species and critical habitat as a result of implementing the project. In this section, we add the effects of the action (Section 2.5) to the environmental baseline (Section 2.4) and the cumulative effects (Section 2.6), taking into account the status of the species and critical habitat (Section 2.2), to formulate the agency's biological opinion as to whether the project is likely to: (1) Reduce appreciably the likelihood of both the survival and recovery of a listed species in the wild by reducing its numbers, reproduction, or distribution; or (2) appreciably diminishes the value of designated or proposed critical habitat for the conservation of the species.

2.7.1 *Summary of the Status of the Species and Critical Habitat*

Populations of SR winter-run and CV spring-run Chinook salmon and CCV steelhead in California have declined drastically over the last century. The current status of listed anadromous fish species has not significantly improved since the species' most recent status reviews (NMFS 2015, 2016a, 2016b, 2016c). The SR winter-run Chinook salmon ESU is constrained to a single population and a concentrated spawning area, which are both susceptible to drought and fluctuating temperatures. The CV spring-run Chinook salmon and CCV steelhead ESUs are constrained by small population sizes and altered habitat that is susceptible to climate change. If measures are not taken to reverse these trends, the recovery and survival potential of SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead will continue to worsen.

The viability of sDPS green sturgeon is constrained by factors such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations.

Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2018).

The critical habitat for all listed fish species in the action area are degraded from their historical conditions, but are still considered critically important to the recovery and conservation of the species for which they were designated.

2.7.2 *Summary of the Environmental Baseline and Cumulative Effects*

The action area encompasses the northern portion of the Yolo Bypass, including the Fremont Weir, Tule Pond, the northern portion of Tule Canal at agricultural road crossing 1, and the Sacramento River where it intersects with the Fremont Weir from RM 83 downstream to RM 79. The action area is considered an important rearing and migratory corridor for all ESA-listed anadromous fish species. Upstream migrating adult sDPS green sturgeon and salmonids may arrive in the northern Yolo Bypass during Fremont Weir overtopping events when the Sacramento River stage is not yet high enough to provide adequate passage over the weir. As agricultural drainages increase throughout the Yolo Bypass, adult salmonids and sturgeon are susceptible to straying into the Yolo Bypass during periods of low flow in the Sacramento River. These agricultural releases act as attraction flows that result in upstream migrating adults to stray into the Yolo Bypass from the Cache Slough Complex, which is south of the Yolo Bypass. During low flow periods, fish passage connectivity to the Sacramento River at Fremont Weir is compromised, which contributes to stranding in this area. Juvenile salmonids and sDPS green sturgeon may enter the Yolo Bypass if their migration down the Sacramento River coincides with a Fremont Weir overtopping event. Both adult and juvenile salmonids and sturgeon have the potential to become stranded in the stilling basin of the Fremont Weir and in nearby scour channels and ponds as floodwaters recede following overtopping events. Listed fish trapped in the shallow waters of the stilling basin and scour channels are vulnerable to poaching, poor water quality, predation, and receding water levels, leading to death. In addition, adult salmonids and sturgeon may experience delays or death if they encounter agricultural road crossings in Tule Canal at lower flows, when the agricultural crossings may not be submerged. The agricultural road crossings become submerged during higher flow conditions, such as when Fremont Weir overtops, eventually allowing salmonids or sturgeon to move beyond them. Adult or juvenile migratory fish, including salmonids and sturgeon, may become trapped in between these crossings as higher flows recede. In consideration of the degraded environmental baseline, this severe decline in populations over time demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area.

Continuing activities described in the environmental baseline and cumulative effects sections include agricultural practices, bank stabilization projects, and recreational boating and fishing which are expected to continue to negatively affect the federally listed anadromous fish species in the action area. The impacts described in the Cumulative Effects section are also expected to further diminish the functional value of critical habitat for the conservation of the species within the action area. For instance, increased demands for water, whether for agricultural purposes or for domestic consumption are expected to continue in the action area, resulting in diminished flows in the river and contributing to higher water temperatures, increased competition for prey and/or cover, and more frequent interactions with predators, all leading to reduced growth and

survival. Runoff from agricultural activities may contain contaminants such as pesticides, sediments, and nutrients that may affect listed species through lethal and sublethal impacts. Levee construction and bank protection can reduce floodplain connectivity, change substrate size, and decrease riparian habitat and shaded riverine aquatic cover. Regional urban development is also expected to continue, although the rate of development may slow due to economic pressures in the area. Therefore, the demand for domestic and municipal water supplies diverted from the Sacramento River Basin are expected to increase to meet these demands in future years, although the rate of increase may be moderate in the near term due to economic trends. As urban development increases in the area, the ability to modify or enhance riparian habitat conditions will be diminished in response to flood management needs for urbanized areas. This circumstance will perpetuate the already degraded status of the critical habitat in the action area and reduce the potential for future environmental restoration actions such as setback levees or flood benches along the river channels.

2.7.3 *Summary of Effects to Listed Species*

Negative effects on listed species include elevated levels of noise from pile driving and turbidity from construction experienced as they migrate through the Sacramento River part of the action area during the roughly 7-month construction period, and injury/mortality related to fish salvage and relocation efforts carried out in conjunction with dewatering the construction area. Operation of the project is expected to provide improved habitat connectivity for ESA-listed fish species to migrate between the Sacramento River and the Yolo Bypass. This enhanced habitat connectivity is expected to improve the ability of anadromous fish to access the Yolo Bypass, resulting in increased growth and decreased stranding events, thereby reducing the necessity and frequency of non-project-related fish rescue efforts (by CDFW), increasing individual fitness and survival, and, potentially, contributing to increased spawning success upstream of the Yolo Bypass. In addition, the hydraulically operated bottom-hinged gate of the fish passage structure takes roughly 60 minutes to fully close, providing fish with ample time to get out of the gate's path of travel. All maintenance activities would be conducted during the non-flood season when listed species are not expected to be present on the Yolo Bypass floodplain.

NMFS has considered the potential effects of the project on listed SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, combined with other activities occurring in the action area, and NMFS determined that the project is not expected to appreciably reduce the likelihood of both the survival and recovery of these species in the wild by reducing their numbers, reproduction, or distribution. This conclusion is also based on the fact that the overall effect of implementing the project will be beneficial to the listed species by improving fish passage, growth, and survival in the Yolo Bypass.

2.7.4 *Summary of Effects to Designated Critical Habitat*

The designated critical habitat in the action area is considered to have a high value for the conservation of listed anadromous fish species. The placement of rock revetment and engineered streambed material in the Yolo Bypass in conjunction with the construction of channel improvements between the headworks structure and Tule Canal, and in association with the agricultural road crossing improvement, will permanently modify the area from the current natural substrate to an artificial substrate. Adult salmonids and sturgeon primarily use the Yolo

Bypass as a migratory corridor. As such, the sections of engineered streambed material replacing natural substrate in the proposed connective channels between the Fremont Weir and the Tule Canal in the Yolo Bypass are not expected to result in behavioral modifications. Juvenile salmonids would not be able to use these sections of channelized streambed for rearing habitat, but, these impacts are expected to be minimal. The permanent modifications to critical habitat and temporary effects at construction sites, represent a small fraction of the fully inundated Yolo Bypass, which provides roughly 59,000 acres of available floodplain rearing habitat after an overtopping event at Fremont Weir. Improving access and reducing stranding is expected to greatly improve the rearing and migratory PBFs for sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon.

Based on the analysis of available evidence, the project is likely to temporarily negatively affect, and permanently modify a small portion of the critical habitat for sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon, but it is not likely to appreciably diminish the value of designated critical habitat for the conservation of the species. Implementation of the project is expected to provide long-term improvements to rearing and migratory PBFs of sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon. Designated critical habitat within the bypass is expected to increase in value for sDPS green sturgeon, CCV steelhead, and CV spring-run Chinook salmon. In a more general sense, this project is expected to increase the overall habitat value for all ESA-listed anadromous fish species in the action area by enhancing habitat connectivity, fish passage, and the overall quality of floodplain rearing habitat in the Yolo Bypass.

2.8 Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the project, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the project is not likely to jeopardize the continued existence of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the southern DPS of North American green sturgeon, or destroy or adversely modify any of their designated critical habitats.

2.9 Incidental Take Statement

Section 9 of the ESA and Federal regulations pursuant to section 4(d) of the ESA prohibit the take of endangered and threatened species, respectively, without a special exemption. "Take" is defined as to harass, harm, pursue, hunt, shoot, wound, kill, trap, capture or collect, or to attempt to engage in any such conduct. "Harm" is further defined by regulation to include significant habitat modification or degradation that actually kills or injures fish or wildlife by significantly impairing essential behavioral patterns, including breeding, spawning, rearing, migrating, feeding, or sheltering (50 CFR 222.102). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1 *Amount or Extent of Take*

In this BO, NMFS determined that the project is reasonably certain to result in the incidental take of individual SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. Incidental take associated with this project is expected to be in the form of mortality, harm, or harassment of both juveniles and adults of all the aforementioned listed species during both the construction and operations and maintenance of the new facilities.

Incidental take during construction activities in the action area is expected to occur due to increased turbidity, underwater noise, increased vulnerability to predation, and restricted access to nearshore riparian habitat along the right bank (looking downstream) of the Sacramento River. Incidental take of listed fish is expected to occur due to the dewatering of the construction site for the intake channel, the headwork structure, and the supplemental fish passage facility. Incidental take in the form of injury, or mortality, harm or harassment, of juvenile SR winter-run and CV spring-run Chinook salmon, as well as both individual adults and juveniles of the CCV steelhead and sDPS green sturgeon populations, are expected to occur as a result of construction activities occurring over an approximately 7-month period from April through October, when individuals from these populations may be present in the Sacramento River.

It is not practical to quantify or track the amount or number of individual listed fish that are expected to be incidentally taken per species as a result of the project, due to the variability associated with the response of listed species to the effects of the project, the varying population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use within the action area and difficulty in observing injured or dead fish.

However, it is possible to estimate the extent of incidental take by designating ecological surrogates, and it is practical to quantify and monitor surrogates to determine the extent of incidental take that is occurring.

The most appropriate thresholds for the extent of incidental take that is expected to occur during construction are the following ecological surrogates: (1) the areal and temporal extent of nearshore riparian habitat affected by construction activities along the banks of the Sacramento River, (2) the level of acoustic noise in the aquatic environment generated during construction, and (3) the extent and duration of turbidity increases in the aquatic environment relative to environmental background conditions during construction. The analysis of the effects of the project anticipates that construction activities associated with the project will result in:

- up to 2 acres of riparian near shore habitat along the right bank of the Sacramento River adjacent to the Fremont Weir being temporarily dewatered and inaccessible to listed anadromous fish species for a period of no more than 7 months during a single construction season. Fish response to inaccessible riparian cover includes displacement, leading to reduced survival due to predation, and reduced feeding, leading to reduced growth.

- listed anadromous fish salvage and relocation efforts following dewatering of 1.15 acres of the right bank of the Sacramento River where it intersects with the construction area

for the proposed inlet channel. Fish response to salvage and relocation efforts includes handling stress, possible injury, and increased susceptibility to predation, leading to reduced fitness and survival.

- acoustic noise generated in the aquatic environment from pile driving and other construction activities that exceeds typical ambient background conditions in the Sacramento River. Based on the types of vehicles and equipment to be used, the methods described for construction, and the effects analysis conducted for this consultation, the amount of sound generated in the aquatic environment associated with the construction activities associated with the project is not expected to exceed 150 dB at a distance of 33 feet from the source activity at any time. Fish response to construction noise, includes displacement, leading to reduced survival due to predation, and reduced feeding, leading to reduced growth.

- increases to the ambient background levels of turbidity in the aquatic environment downstream from the construction sites on the Sacramento River. Based on the types of vehicles and equipment to be used, the methods described for construction, and the effects analysis conducted for this consultation, the increases in turbidity above ambient background conditions in the aquatic environment are expected to extend a distance of 328 feet downstream from the construction site.

Additionally, the analysis of the effects of the project anticipates that operation and maintenance of the fish passage structure will result in:

- a decrease of up to approximately 100 feet of riparian near shore habitat along the right bank of the Sacramento River adjacent to the Fremont Weir. Listed anadromous fish response to inaccessible riparian cover includes displacement leading to reduced survival due to predation, and reduced feeding, leading to reduced growth.

- the permanent loss of 34.64 acres of rearing habitat within the footprint of the constructed channel, the headwork structure, and Tule Canal through the placement of rock revetment and engineered streambed material in the Yolo Bypass. Listed anadromous fish response to this unavailable rearing habitat includes reduced growth as a result of diminished prey availability and increased competition for limited resources.

If the limits to the extent of incidental take represented by these ecological surrogates are not met and maintained, the proposed Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation.

2.9.2 *Effect of the Take*

In the BO, NMFS determined that the amount or extent of anticipated take coupled with other effects of the proposed action is not likely to result in jeopardy to the species or destruction or adverse modification of critical habitat.

2.9.3 *Reasonable and Prudent Measures*

"Reasonable and prudent measures" are nondiscretionary measures that are necessary or appropriate to minimize the impact of the amount or extent of incidental take (50 CFR 402.02).

NMFS thinks the following reasonable and prudent measures are necessary and appropriate to minimize the take of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and the sDPS green sturgeon:

(1) Reclamation shall minimize impacts to listed species and their critical habitats from project specific activities;

(2) Reclamation shall take measures to ensure implementation of the monitoring and adaptive management as detailed in the BA.

2.9.4 *Terms and Conditions*

The terms and conditions described below are non-discretionary, and the U.S. Bureau of Reclamation, or any applicant must comply with them in order to implement the RPMs (50 CFR 402.14). The U.S. Bureau of Reclamation or any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the project would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:

    a. Reclamation shall not employ any chemical methods of vegetation control or removal associated with this project in the action area, including during future maintenance activities.

    b. Throughout the life of the project, anytime Reclamation uses an impact pile driver hammer within 100 feet of aquatic habitat within the action area, Reclamation shall conduct acoustic monitoring. Acoustic monitoring must be designed to detect when pile driving activities generate noise levels in excess of 150 dB in the aquatic environment within 33 feet of either the acoustic signal source in the water, or the shoreline closest to the acoustic signal source if it is land based. If the 150 dB threshold is exceeded, pile driving operations shall halt until noise levels dissipate to background levels.

    c. Reclamation shall monitor surface water quality by measuring turbidity 300 feet downstream from active construction sites at a depth approximately two thirds of the total water depth. Turbidity measurements shall be taken twice daily during construction activities, and any increases shall not exceed 15 NTUs above ambient background levels in successive samples taken from the action area. If this threshold is exceeded, the monitoring equipment should be inspected and a second measurement taken to confirm the exceedance. If the exceedance is confirmed to persist after a second measurement, construction activity shall be immediately halted until conditions subside and turbidity

levels return to a level that is compliant with the CVRWQCB standard as described above.

d. Reclamation shall complete preparation of a comprehensive Fish Rescue and Salvage Plan in coordination with NMFS, providing detailed descriptions of procedures and gear types to be employed for fish relocation and dewatering efforts prior to the commencement of any construction activities associated with this project.

e. Any SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon found dead or injured within the action area during construction shall be reported within 48 hours to NMFS via fax or by phone:

Attention Supervisor, NMFS California Central Valley Office
Fax: (916) 930-3629
Phone: (916) 930-3600

A follow-up written notification shall also be submitted to NMFS which includes the date, time, and location that the carcass or injured specimen was found, a color photograph, the cause of injury or death, if known, and the name and affiliation of the person who found the specimen. Written notification shall be submitted to:

Supervisor, California Central Valley Office
National Marine Fisheries Service
650 Capitol Mall, Suite 5-100
Sacramento, California 95814

Any dead specimen(s) should be placed in a cooler with ice and held for pick up by NMFS personnel or an individual designated by NMFS to do so.

f. Within 30 days of completing construction activities associated with the project, Reclamation shall submit a report to NMFS describing the work that was performed, the starting and ending dates of the construction actions, any observed adverse effects to aquatic habitats and their duration (i.e., increased suspended sediment levels or turbidity, instances of pollution, unusual animal behaviors in adjacent waters, etc.), or any other problems encountered during construction activities.

2. The following terms and conditions implement reasonable and prudent measure 2:

a. Every 3 years hereafter, Reclamation shall provide a report to NMFS, which shall include, but is not necessarily limited to, evaluating the effectiveness of the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project (project) achieving its: biological objectives and performance goals; operational criteria; key milestones; associated monitoring; restoration actions, including actions to minimize stranding or migration barriers for juvenile salmon and the ability of the project to allow juvenile salmon onto the Yolo Bypass floodplain; and the intervention thresholds mentioned below.

- Up to 5 years of initial operations may be needed to test notch operations for feasibility concerns and protection of property before full notch operations are realized.
- **Intervention Threshold:** Duration of juvenile Chinook salmon presence (during times when juvenile salmon are typically present at the south Yolo Bypass screw trap site) is shorter than during years with operation of the Fremont Weir notch than without operation.
  - **Potential Management Response:** Lengthen period of Fremont Weir notch operation between first and last operational dates during the Fremont Weir notch operation period. Evaluate extending the period of Fremont Weir Notch operation. Potential actions stemming from this evaluation may be subject to additional economic analysis and environmental permitting, including California Environmental Quality Act (CEQA) and National Environmental Policy Act (NEPA).
- **Intervention Threshold**: Range of sizes of juvenile Chinook salmon at the south Yolo Bypass screw trap site is narrower during years with operation of the Fremont Weir notch than without operation.
  - **Potential Management Response**: Evaluate extending the period of Fremont Weir Notch operation. Potential actions stemming from this evaluation may be subject to additional economic analysis and environmental permitting, including CEQA and NEPA.

b. Reclamation and DWR shall keep NMFS informed and involved in science planning and adaptive management governance related to the operations of the project consistent with applicable governance and consultation procedures, and terms of this BO.

2.10 Conservation Recommendations

Section 7(a)(1) of the ESA directs Federal agencies to use their authorities to further the purposes of the ESA by carrying out conservation programs for the benefit of the threatened and endangered species. Specifically, conservation recommendations are suggestions regarding discretionary measures to minimize or avoid adverse effects of a project on listed species or critical habitat or regarding the development of information (50 CFR 402.02).

(1) Reclamation should perform contaminants testing on all excavated materials that are to be set aside for potential re-use to ensure the thresholds consistent with the regulatory requirements for obtaining Section 401 Water Quality Certification under the Clean Water Act, as administered by the CVRWQCB waste discharge requirements, are not exceeded. Any materials that testing reveals to contain concentrations of contaminants in excess of those regulatory thresholds, should be transported for offsite containment or disposal as soon as practicable and consistent with applicable regulatory requirements.

(2) Reclamation should support and promote aquatic and riparian habitat restoration in the Sacramento River basin for listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.

(3) Reclamation should continue to look for opportunities to restore floodplain habitat on the Sacramento River specifically to be used for juvenile CV spring-run Chinook salmon that migrate in late spring (March-May).

(4) Reclamation should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

(5) Reclamation should use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery, and to identify key actions in the action area when prioritizing project sites each year.

In order for NMFS to be kept informed of actions minimizing or avoiding adverse effects or benefitting listed species or their habitats, NMFS requests notification of the implementation of any conservation recommendations.

2.11 Reinitiation of Consultation

This concludes formal consultation for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. As 50 CFR 402.16 states, reinitiation of formal consultation is required where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this BO, (3) the agency action is subsequently modified in a manner that causes an effect on the listed species or critical habitat that was not considered in this BO, or (4) a new species is listed or critical habitat designated that may be affected by the project. An operational end date earlier than March 15 was not considered in this BO and may cause unanalyzed effects to listed species or critical habitat that would trigger reinitiation of consultation. (Consistent with the analysis in this BO, reinitiation would only be warranted after full notch operation and excluding the need to alter operations for safety and emergencies.)

3. MAGNUSON-STEVENS FISHERY CONSERVATION AND MANAGEMENT ACT ESSENTIAL FISH HABITAT RESPONSE

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. The MSA (section 3) defines EFH as "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity." Adverse effect means any impact that reduces quality or quantity of EFH, and may include direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) also requires NMFS to recommend measures that can be taken by the Action Agency to conserve EFH.

This analysis is based, in part, on the EFH assessment provided by Reclamation and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the Pacific Fishery Management Council (PFMC) and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 2000). The action area is within the region identified as EFH for Pacific salmon in Amendment 14 of the Pacific Coast Salmon FMP. Freshwater EFH for Pacific salmon in the California Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the San Joaquin Delta (Delta) hydrologic unit (i.e., number 18040003). Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CV fall-/late fall-run Chinook salmon are species managed under the Pacific Coast Salmon FMP that occur in the Delta unit.

The Sacramento River mainstem and the Yolo Bypass within the action area provide upstream migratory habitat for adult Chinook salmon, and downstream migratory and rearing habitat for all Chinook salmon runs. Chinook salmon juveniles may rear throughout the action area; however, spawning does not occur in the action area, as Chinook salmon spawning occurs well upstream.

3.2 Adverse Effects on Essential Fish Habitat

Temporary adverse construction impacts of this project include pile driving noise and increased turbidity. The full impacts of the project on Chinook salmon habitat are the same as those described in section 2.5 of this BO and are generally expected to apply to Pacific salmon EFH. Ultimately, the operations of this project are expected to have a beneficial effect on EFH.

3.3 Essential Fish Habitat Conservation Recommendations

The project includes adequate measures described in Section 1.3 of this BO to avoid, minimize, or otherwise offset the adverse effects to EFH. Therefore, additional EFH Conservation Recommendations are not being provided at this time. However, if there are revisions to the project description that may result in adverse effects to EFH, Reclamation will need to re-initiate EFH consultation.

3.4 Supplemental Consultation

Reclamation must reinitiate EFH consultation with NMFS if the project is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations (50 CFR 600.920(l)).

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

The Data Quality Act (DQA) specifies three components contributing to the quality of a document. They are utility, integrity, and objectivity. This section of the BO addresses these DQA components, documents compliance with the DQA, and certifies that this BO has undergone pre-dissemination review.

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this BO are Reclamation. Other interested users could include DWR, CDFW, and U.S. Fish and Wildlife Service. Individual copies of this BO were provided to Reclamation. The format and naming adheres to conventional standards for style.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in Appendix III, 'Security of Automated Information Resources,' Office of Management and Budget Circular A-130; the Computer Security Act; and the Government Information Security Reform Act.

4.3 Objectivity

Information Product Category: Natural Resource Plan

Standards: This consultation and supporting documents are clear, concise, complete, and unbiased; and were developed using commonly accepted scientific research methods. They adhere to published standards including the NMFS ESA Consultation Handbook, ESA regulations, 50 CFR 402.01 et seq., and the MSA implementing regulations regarding EFH, 50 CFR 600.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this BO and EFH consultation contain more background on information sources and quality.

Referencing: All supporting materials, information, data and analyses are properly referenced, consistent with standard scientific referencing style.

Review Process: This consultation was drafted by NMFS staff with training in ESA and MSA implementation, and reviewed in accordance with West Coast Region ESA quality control and assurance processes.

5. REFERENCES

Barrett, J. C., G. D. Grossman, and J. Rosenfeld. 1992. Turbidity-Induced Changes in Reactive Distance of Rainbow Trout. Transactions of the American Fisheries Society 121(4):437-443.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of Turbidity and Suspended Solids on Salmonids University of Washington Water Center

Beechie, T., H. Imaki, J. Greene, A. Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Stanford, P. Kiffney, and N. Mantua. 2012. Restoring Salmon Habitat for a Changing Climate. River Research and Applications 29(8):939-960.

Bisson, P. A. and R. E. Bilby. 1982. Avoidance of Suspended Sediment by Juvenile Coho Salmon. North American Journal of Fisheries Management 2(4):371-374.

Bjornn, T. C. and D. W. Reiser. 1991. Habitat Requirements of Salmonids in Streams. Pages 83-138 *in* Influences of Forest and Rangeland Management on Salmonid Fishes and Their Habitats, W. R. Meehan, editor. American Fisheries Society.

Burgess, W. C. and S. B. Blackwell. 2003. Acoustic Monitoring of Barrier Wall Installation at the Former Rhone-Poulenc Site, Tukwila, Washington. RCI Environmental, Inc., Santa Barbara, California.

CALFED Bay-Delta Program. 2000. Ecosystem Restoration Program Plan Volume I: Ecological Attributes of the San Francisco Bay-Delta Watershed: Final Programmatic Eis/Eir Technical Appendix. CALFED Bay-Delta Program.

California Department of Fish and Game (CDFG). 2002. California Department of Fish and Game Comments to National Marine Fisheries Service Regarding Green Sturgeon Listing. 1-83 pp.

California Department of Fish and Wildlife (CDFW). 2011. "Successful Fish Rescue Completed at Tisdale and Fremont Weir off Sacramento River." Online article in *CDFW News*, April 15. Accessed October 2016. https://cdfgnews.wordpress.com/2011/04/15/successful-fish-rescue-completed-at-tisdale-and-fremont-weir-off-sacramento-river/.

California Department of Fish and Wildlife (CDFW). 2016. Summary of Fish Rescues Conducted within the Yolo and Sutter Bypasses. Prepared by Marc Beccio for the U.S. Bureau of Reclamation, Bay Delta Office. North Central Region.

California Department of Fish and Wildlife (CDFW). 2018. California Central Valley Chinook Population Database Report, Fisheries Branch Anadromous Assessment, Grandtab.

California Department of Water Resources (DWR). 2017. Evaluating Adult Salmonid and Sturgeon Passage Potential for Multiple Modified Fremont Weir Configurations.

Technical memorandum for the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project.

California Department of Water Resources (DWR). Unplublished data. Yolo Bypass Fish Monitoring Database.

Carlson, T. J., G. R. Ploskey, R. Johnson, R. P. Mueller, M. A. Weiland, and P. Johnson. 2001. Observations of the Behavior and Distribution of Fish in Relation to the Columbia River Navigation Channel and Channel Maintenance Activities. Pacific Northwest National Lab.(PNNL), Richland, WA (United States).

Central Valley Regional Water Quality Control Board. 2010. 2010 California 303(d) List of Water Quality Limited Segments. Accessed March 3, 2017. http://www.waterboards.ca.gov/centralvalley/water_issues/tmdl/impaired_waters_list/2008_2010_usepa_303dlist/20082010_usepa_aprvd_303dlist.pdf.

Cohen, S. J., K. A. Miller, A. F. Hamlet, and W. Avis. 2000. Climate Change and Resource Management in the Columbia River Basin. Water International 25(2):253-272.

Daughton, C. G. 2003. Cradle-to-Cradle Stewardship of Drugs for Minimizing Their Environmental Disposition While Promoting Human Health. Ii. Drug Disposal, Waste Reduction, and Future Directions. Environmental Health Perspectives 111(5):775-785.

Dettinger, M. D. and D. R. Cayan. 1995. Large-Scale Atmospheric Forcing of Recent Trends toward Early Snowmelt Runoff in California. Journal of Climate 8(3):606-623.

Dimacali, R. L. 2013. A Modeling Study of Changes in the Sacramento River Winter-Run Chinook Salmon Population Due to Climate Change. Master's Thesis. California State University, Sacramento.

Dubrovsky, N. M., D.L. Knifong, P.D. Dileanis, L.R. Brown, J.T. May, V. Connor, and C.N. Alpers. 1998. Water Quality in the Sacramento River Basin. U.S. Geological Survey Circular 1215. United States Geological Survey.

Feist, B. E., J. J. Anderson, and R. Miyamoto. 1992. Potential Impacts of Pile Driving on Juvenile Pink (*Oncorhynchus gorbuscha*) and Chum (*O. keta*) Salmon Behavior and Distribution. University of Washington.

Fisheries Hydroacoustic Working Group (FHWG). 2008. Agreement in Principal for Interim Criteria for Injury to Fish from Pile Driving Activities. Memorandum. June 12. Available at: http://www.dot.ca.gov/hq/env/bio/files/fhwgcriteria_agree.pdf.

Goertler, P., J. Frantzich, B. Schreier, and T. Sommer. 2015. Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*) Occupy the Yolo Bypass in Relatively High Numbers During an Extreme Drought. IEP Newsletter 28(1):19-29.

Gregory, R. S. and C. D. Levings. 1998. Turbidity Reduces Predation on Migrating Juvenile Pacific Salmon. Transactions of the American Fisheries Society 127(2):275-285.

Heublein, J. C., J. T. Kelly, C. E. Crocker, A. P. Klimley, and S. T. Lindley. 2009. Migration of Green Sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fishes 84(3):245-258.

Katz, J. 2012. The Knaggs Ranch Experimental Agricultural Floodplain Pilot Study 2011–2012, Year One Review. University of California, Davis.

Katz, J., C. Jeffres, L. Conrad, T. Sommer, N. Corline, J. Martinez, S. Brumbaugh, L. Takata, N. Ikemiyagi, and J. Kiernan. 2013. Experimental Agricultural Floodplain Habitat Investigation at Knaggs Ranch on Yolo Bypass, 2012–2013. Sacramento (CA): US Bureau of Reclamation.

Lindley, S. 2008. California Salmon in a Changing Climate. Sacramento, California. PowerPoint presentation.

Lloyd, D. S. 1987. Turbidity as a Water Quality Standard for Salmonid Habitats in Alaska. North American Journal of Fisheries Management 7(1):34-45.

McClure, M. M. 2011. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. Norwest Fisheries Science Center. (NMFS-NWFSC-113):pg 281.

McEwan, D. R. 2001. Contributions to the Biology of Central Valley Salmonids. Fish Bulletin 1:1-44.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California., U.S. Department of Commerce Report No. NMFSNWFSC-35. NOAA Tech. Memo.

National Marine Fisheries Service. 2009. NMFS Biological and Conference Opinion on the Long-Term Operations of the Central Valley Project and State Water Project. Southwest Region, Long Beach, California. 844 pp.

National Marine Fisheries Service. 2014. Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. California Central Valley Area Office. 428 pp.

National Marine Fisheries Service. 2015. 5-Year Summary and Evaluation: Southern Distinct Population Segment of the North American Green Sturgeon. U.S. Department of Commerce, National Marine Fisheries Service, West Coast Region, California Central Valley Office, Sacramento, California. 42 pp.

National Marine Fisheries Service. 2016a. 5-Year Status Review: Summary and Evaluation of Sacramento River Winter-Run Chinook Salmon ESU. U.S. Department of Commerce, National Marine Fisheries Service, West Coast Region, California Central Valley Office, Sacramento, California. 1-41 pp.

National Marine Fisheries Service. 2016b. California Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of Central Valley Spring-Run Chinook Salmon ESU. U. S. Department of Commerce, National Marine Fisheries Service, West Coast Region, California Central Valley Office, Sacramento, California. 1-41 pp.

National Marine Fisheries Service. 2016c. Central Valley Recovery Domain 5-Year Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. U.S. Department of Commerce, National Marine Fisheries Service, West Coast Region, California Central Valley Office, Sacramento, California. 1-44 pp.

National Marine Fisheries Service. 2018. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (*Acipenser medirostris*). U.S. Department of Commerce, National Marine Fisheries Service, West Coast Region, California Central Valley Office, Sacramento, California.. 95 pp.

Newcombe, C. P. and O. T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management 16:693-727.

Newcombe, C. P. and D. D. MacDonald. 1991. Effects of Suspended Sediments on Aquatic Ecosystems. North American Journal of Fisheries Management 11:72-82.

Nightingale, B. and C. A. Simenstad. 2001. Dredging Activities: Marine Issues. Research Project T1802, Task 35, Overwater Whitepaper, Washington State Transportation Commission.

PFMC (Pacific Fishery Management Council). 2000. Incorporating the Reglatory Impact Review/Intial Reglatory Flexibility Analysis and Final Supplemental Environmental Impact Statement. Amendemtn 14, Appendix A: Identification and Description of Essential Fish Habiat, Adverse Impacts, and Recommended Conservation Measures for Salmon. Pacific Fishery Management Council, Portland, Oregon. May.

PFMC. 2014. Appendix A to the Pacific Coast Salmon Fishery Management Plan, as modified by Amendment 18. Identification and description of essential fish habitat, adverse impacts, and recommended conservation measures for salmon.

Shafiei Sabet, S., E. Neo, and H. Slabbekoorn. 2015. Impact of Anthropogenic Noise on Aquatic Animals: From Single Species to Community-Level Effects. In: The Effects of Noise on Aquatic Life II. Springer, New York, NY. 957-961.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of Chronic Turbidity on Density and Growth of Steelheads and Coho Salmon. Transactions of the American Fisheries Society 113(2):142-150.

Snider, B. and R. G. Titus. 2000. Timing, Composition and Abundance of Juvenile Anadromous Salmonid Emigration in the Sacramento River near Knights Landing October 1998–September 1999. California Department of Fish and Game, Stream Evaluation Program Technical Report No. 00-6.

Sommer, T. R., M. L. Nobriga, W. C. Harrell, W. Batham, and W. J. Kimmerer. 2001a. Floodplain Rearing of Juvenile Chinook Salmon: Evidence of Enhanced Growth and Survival. Canadian Journal of Fisheries and Aquatic Sciences 58(2):325-333.

Sommer, T., B. Harrell, M. Nobriga, R. Brown, P. Moyle, W. Kimmerer, and L. Schemel. 2001b. "California's Yolo Bypass: Evidence that Flood Control can be Compatible with Fisheries, Wetlands, Wildlife, and Agriculture." *Fisheries* 26(8): 6–16.

Sommer, T. R., W. C. Harrell, A. M. Solger, B. Tom, and W. Kimmerer. 2004. Effects of Flow Variation on Channel and Floodplain Biota and Habitats of the Sacramento River, California, USA. Aquatic Conservation: Marine and Freshwater Ecosystems 14(3):247-261.

Sommer, T. R., W. C. Harrell, and T. J. Swift. 2008. Extreme Hydrologic Banding in a Large-River Floodplain, California, USA. Hydrobiologia 598(1):409-415.

Thomas, M. J., M. L. Peterson, N. Friedenberg, J. P. Van Eenennaam, J. R. Johnson, J. J. Hoover, and A. P. Klimley. 2013. Stranding of Spawning Run Green Sturgeon in the Sacramento River: Post-Rescue Movements and Potential Population-Level Effects. North American Journal of Fisheries Management 33(2):287-297.

Thompson, L. C., M. I. Escobar, C. M. Mosser, D. R. Purkey, D. Yates, and P. B. Moyle. 2011. Water Management Adaptations to Prevent Loss of Spring-Run Chinook Salmon in California under Climate Change. Journal of Water Resources Planning and Management: 138:465-478.

U.S. Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR). 2012. Yolo Bypass Salmonid Habitat Restoration and Fish Passage Implementation Plan.

U.S. Bureau of Reclamation (Reclamation) and California Department of Water Resources (DWR). 2017. Fremont Weir Adult Fish Passage Modification Project Final Intial Study/ Environmental Assessment. 276 pages.

U.S. Fish and Wildlife Service (USFWS). 2019. Biological Opinion on the Yolo Bypass Salmonid Habitat Restoration and Fish Passage Project. USFWS, Bay-Delta Office, Sacramento, California. 45 pages.

Wade, A. A., T. J. Beechie, E. Fleishman, N. J. Mantua, H. Wu, J. S. Kimball, D. M. Stoms, and J. A. Stanford. 2013. Steelhead Vulnerability to Climate Change in the Pacific Northwest. Journal of Applied Ecology 50:1093-1104.

Williams, J. G. 2006. Central Valley Salmon: A Perspective on Chinook and Steelhead in the Central Valley of California. San Francisco Estuary and Watershed Science 4:416.

Williams, P. B., E. Andrews, J. J. Opperman, S. Brozkurt, and P. B. Moyle. 2009. Quantifying Activated Floodplains on a Lowland Regulated River: Its Applications to Floodplain Restoration in the Sacramento Valley. San Francisco Estuary and Watershed Science 7(1).

Yates, D., H. Galbraith, D. Purkey, A. Huber-Lee, J. Sieber, J. West, S. Herrod-Julius, and B. Joyce. 2008. Climate Warming, Water Storage, and Chinook Salmon in California's Sacramento Valley. Climatic Change 91(3-4):335-350.