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-2017-8272

November 17, 2017

Nancy Haley
Chief of the CA North Branch Regulatory Division
United States Army Corps of Engineers
Sacramento District
1325 J Street
Sacramento, California 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion, Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response, and Fish and Wildlife Coordination Act Recommendations for the Oroville Wildlife Area Flood Stage Reduction Project

Dear Ms. Haley:

Thank you for your letter of 12 January 2017, requesting initiation of consultation with NOAA's 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 Oroville Wildlife Area Flood Stage Reduction Project.

Based on the best available scientific and commercial information, the biological opinion concludes that the Oroville Wildlife Area Flood Stage Reduction Project is not likely to jeopardize the continued existence of the federally listed threatened Central Valley (CV) spring-run Chinook salmon evolutionarily significant unit (ESU) *(Oncorhynchus tshawytscha),* threatened California Central Valley (CCV) steelhead distinct population segment (DPS) (*O. mykiss),* or the threatened southern DPS (sDPS) of North American green sturgeon *(Acipenser medirostris)*, and is not likely to destroy or adversely modify their designated critical habitats. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and non-discretionary terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

NMFS reviewed the likely effects of the proposed action on essential fish habitat (EFH), pursuant to section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)), and concluded that the action would adversely affect the EFH of Pacific Coast Salmon. Therefore, we have included the results of that review in Section 3 of this document.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (16 U.S.C. 661 *et seq.*).

Please contact Jahnava Duryea at the NMFS California Central Valley Office at (916) 930-3725 or by email at Jahnava.Duryea@noaa.gov, if you have any questions concerning this section 7 consultation, or if you require additional information.

Sincerely,

Maria Rea
for

Barry A. Thom
Regional Administrator

Enclosure

cc: ARN: 151422-WCR2017-SA00306
Mr. Michael Bessette, Sutter Butte Flood Control Agency, m.bessette@sutterbutteflood.org
Ms. Monique Briard, ICF International, monique.briard@icfi.com
Ms. Melissa France, U.S. Army Corps of Engineers, Melissa.M.France@usace.army.mil

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

Oroville Wildlife Area Flood Stage Reduction
NMFS Consultation Number: WCR-2017-8272

Action Agency: U.S. Army Corps of Engineers

Affected Species and NMFS' Determinations:

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

Fishery Management Plan That Describes EFH in the Project Area	Does Action Have an Adverse Effect on EFH?	Are EFH Conservation Recommendations Provided?
Pacific Coast Salmon	Yes	Yes

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

Issued By: Maria Rea

for Barry A. Thom
Regional Administrator

Date: November 17, 2017

LIST OF ACRONYMS

ACID – Anderson-Cottonwood Irrigation Dam
AF – acre-feet
CVRWQCB – Central Valley Regional Water Quality Control Board
BA – biological assessment
BMPs – best management practices
°C – degrees Celsius
CCV – California Central Valley
CCVO – California Central Valley Office
CDFG – California Department of Fish and Game
CDFW – California Department of Fish and Wildlife
CFR – Code of Federal Register
CFS – cubic feet per second
CMP – corrugated metal pipe
Corps – United States Army Corps of Engineers
CV – Central Valley
CVP – Central Valley Project
dB – decibels
DO – dissolved oxygen
DPS – distinct population segment
DQA – Data Quality Act
DWR – California Department of Water Resources
EFH – essential fish habitat
ESA – Endangered Species Act
ESU – evolutionarily significant unit
°F – degrees Fahrenheit
FERC – Federal Energy Regulatory Commission
FMP – Fishery Management Plan
FR – Federal Register
FRFH – Feather River Fish Hatchery
FSRP – Flood Stage Reduction Project
FWCA – Fish and Wildlife Coordination Act
GCID – Glenn-Colusa Irrigation District
HAPC – habitat area of particular concern
ICF – consulting firm ICF International
IHNV – infectious hematopoietic necrosis virus
IPCC – Intergovernmental Panel on Climate Change
ITS – incidental take statement
LFC – low flow channel
LWM – large woody material
MSA – Magnuson-Stevens Fishery Conservation and Management Act
nDPS – northern distinct population segment
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration

NTUs – Nephelometric Turbidity Units
OHWM – ordinary high water mark
opinion – biological opinion
OWA – Oroville Wildlife Area
PBF – physical and biological features
PCE – primary constituent elements
RBDD – Red Bluff Diversion Dam
RM – river mile
RSP – rock slope protection
SB88 – Senate Bill no. 88
SBFCA – Sutter Butte Flood Control Agency
sDPS – southern distinct population segment
SEWD – Sutter Extension Water District
SJRRP – San Joaquin River Restoration Project
SPCCP – spill prevention, control, and counter-measure plan
SRA – shaded riverine aquatic
SWE – snow water equivalent
SWFSC – Southwest Fisheries Science Center
SWP – State Water Project
SWPPP – stormwater pollution prevention plan
SWRCB – State Water Resources Control Board
T&C – term and condition
TSS – total suspended solids
USACE – United States Army Corps of Engineers (Corps)
USBOR – United States of Bureau of Reclamation (Reclamation)
USFWS – United States Fish and Wildlife Service
VSP – viable salmonid population

TABLE OF CONTENTS

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 (opinion) and incidental take statement (ITS) portions of this document in accordance with Section 7(b) 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 proposed action, 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.

Because the proposed action would modify a stream or other body of water, NMFS also provides recommendations and comments for the purpose of conserving fish and wildlife resources, and enabling the Federal agency to give equal consideration with other project purposes, as required under the Fish and Wildlife Coordination Act (FWCA) (16 U.S.C. 661 *et seq.*).

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 (Section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available through NMFS' Public Consultation Tracking System (https://pcts.nmfs.noaa.gov/). A complete record of this consultation is on file at NMFS' California Central Valley Office (CCVO).

1.2 Consultation History

- **20 September 2016** – On the behest of the applicant, the Sutter Butte Flood Control Agency (SBFCA), the consulting firm ICF hosted a site visit to the Oroville Wildlife Area (OWA) for representatives from the resource agencies including California Department of Fish and Wildlife (CDFW), California Department of Water Resources (DWR), and NMFS. The group toured various sites in the D-Unit of the OWA and discussed actions relevant to the Flood Stage Reduction Project (FSRP). In attendance were resource agency representatives Jahnava Duryea (NMFS); Kursten Sheridan, Isabel Baer, A.J. Dill, Dave VanBaren (CDFW); Ryan Martin (DWR); Monique Briard, Jennifer Haire, Michael Vondergeest, and Bill Mitchell (ICF).

- **25 January 2017** – NMFS West Coast Region CCVO received a consultation initiation request and Biological Assessment (BA) from the U.S. Army Corps of Engineers (Corps) for the OWA FSRP.

- **26 January 2017** – NMFS initiated formal consultation on the OWA FSRP.

- **1 June 2017 –** Jahnava Duryea (NMFS) and Monique Briard (ICF) had a phone conversation to update each other on the water levels within the D-Unit of the OWA following the heavy 2016-2017 flood season and the status of the opinion. Following the conversation Monique provided two technical memos that addressed concerns regarding mercury mobilization and methylation in the project area.

- **26 September to 24 October 2017 –** In a series of emails, Jahnava Duryea (NMFS) requested additional information from Monique Briard (ICF), who provided grading and pile driving specifications for work at the notch connection site.

A complete administrative record is on file at the NMFS CCVO.

1.3 Proposed Federal Action

"Action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (50 CFR § 402.02). The Corps applicant, SBFCA, proposes to reduce flood stages within the main channel of the Feather River by improving connectivity to its historic floodplain. Within the OWA, the weir system that diverts floodwaters into the OWA D-Unit with the purpose of reducing downstream flood stages is not functioning as designed. The original weir was designed to divert approximately 80,000 cubic feet per second (cfs) from the main channel into the OWA D-Unit during the peak of a 200-year event, reducing peak stages downstream through attenuation. However, analysis done for SBFCA has indicated that the current weir configuration only diverts approximately 40,000 cfs during the peak of a 200-year event. The goal of the FSRP is to improve the current OWA weir system to meet the original design capacity, thereby achieving a stage reduction of approximately 0.7 feet in the main channel of the Feather River. In addition, the proposed action is also expected to improve conditions in the OWA D-Unit that have caused fish stranding, hydraulic isolation, poor water quality, and widespread aquatic invasive plants.

"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 interrelated or interdependent actions associated with the proposed action.

1.3.1 Project Location

The Project is located in the OWA, which encompasses 11,869 acres of the lower Feather River corridor just downstream of the city of Oroville in Butte County, CA **(**Figure 1). The OWA is adjacent to the left bank of the Feather River between the Thermalito Afterbay and State Route 70. The OWA The upstream boundary of the OWA is located along Hwy 162 at river mile (RM) 63.9 and extends approximately 11.5 miles downstream to RM 53.7.

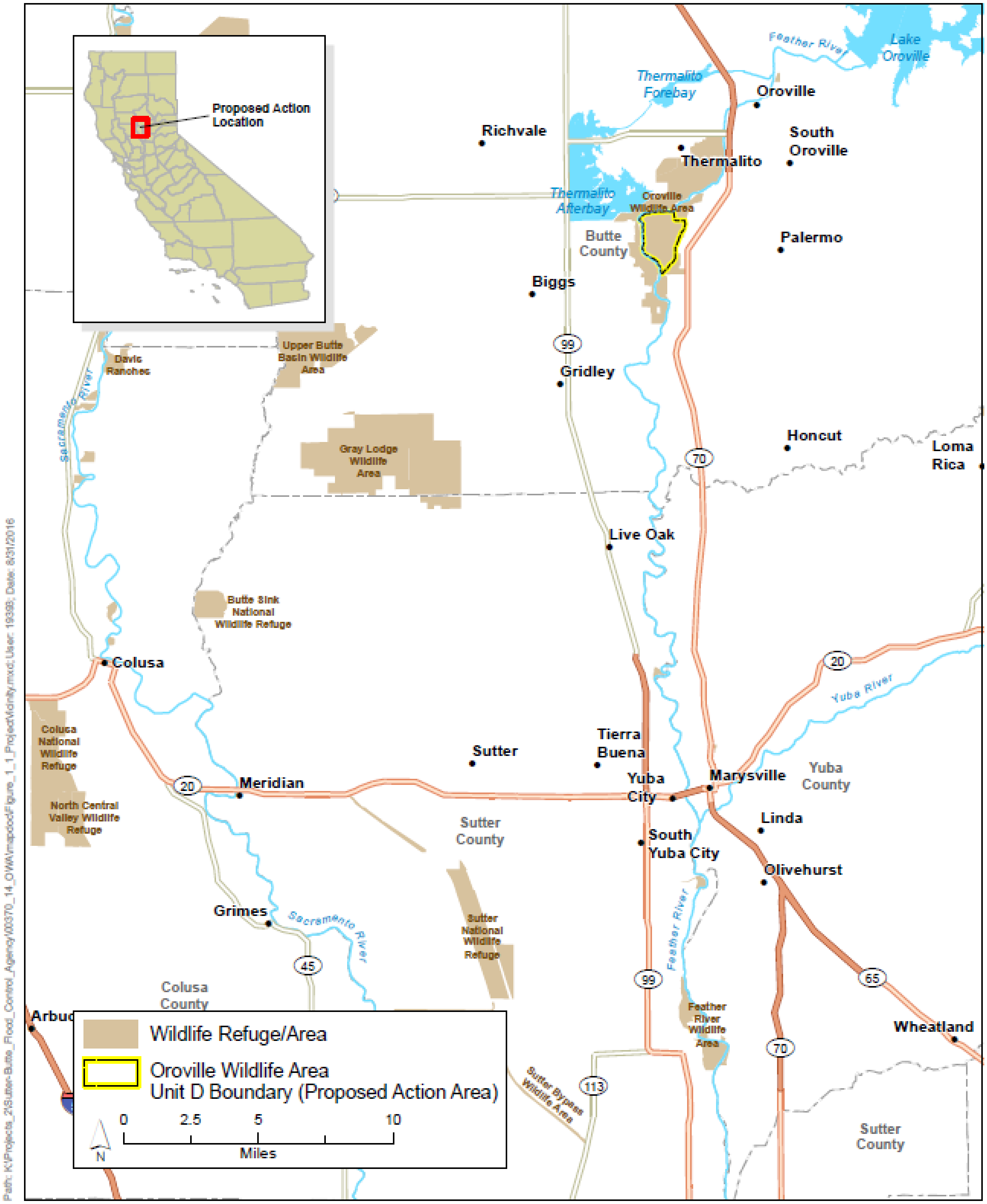

Figure 1. Map of the Project Location and Vicinity.

1.3.2 Project Description

The objectives of the proposed action are to enhance fish and wildlife habitat, restore native vegetation, improve the connectivity of the Feather River to its historic floodplain, and reduce flood stages in the main channel, thereby reducing scour of streambed and margins. The proposed action is expected to provide a more natural flood corridor both in the action area and downstream, provide more frequently inundated floodplain-rearing habitat for juvenile salmonids, and reduce the extent of invasive plant species.

More specifically, the proposed action would:

- Increase hyporheic recharge and discharge; hyporheic discharge to the river cools stream temperatures, particularly in the spring as temperature rises.
- Improve functional value of existing flow regime to native fish and wildlife species by restoring river-floodplain connectivity.
- Restore the action area floodplain, which would lead to increased channel complexity that would result in better water quality and habitat throughout the reach.
- Restore riparian vegetation to shade the flows that flood the action area and reduce water temperatures.
- Remove invasive plants in the action area, substantially reducing or eliminating the contributions of this ecological stressor of the downstream environment.

The proposed action consists of three components:

(1) vegetation management and restoration,
(2) hydraulic improvements, and
(3) recreational enhancement.

Figure 2 provides an overview of the components of the Proposed Action.

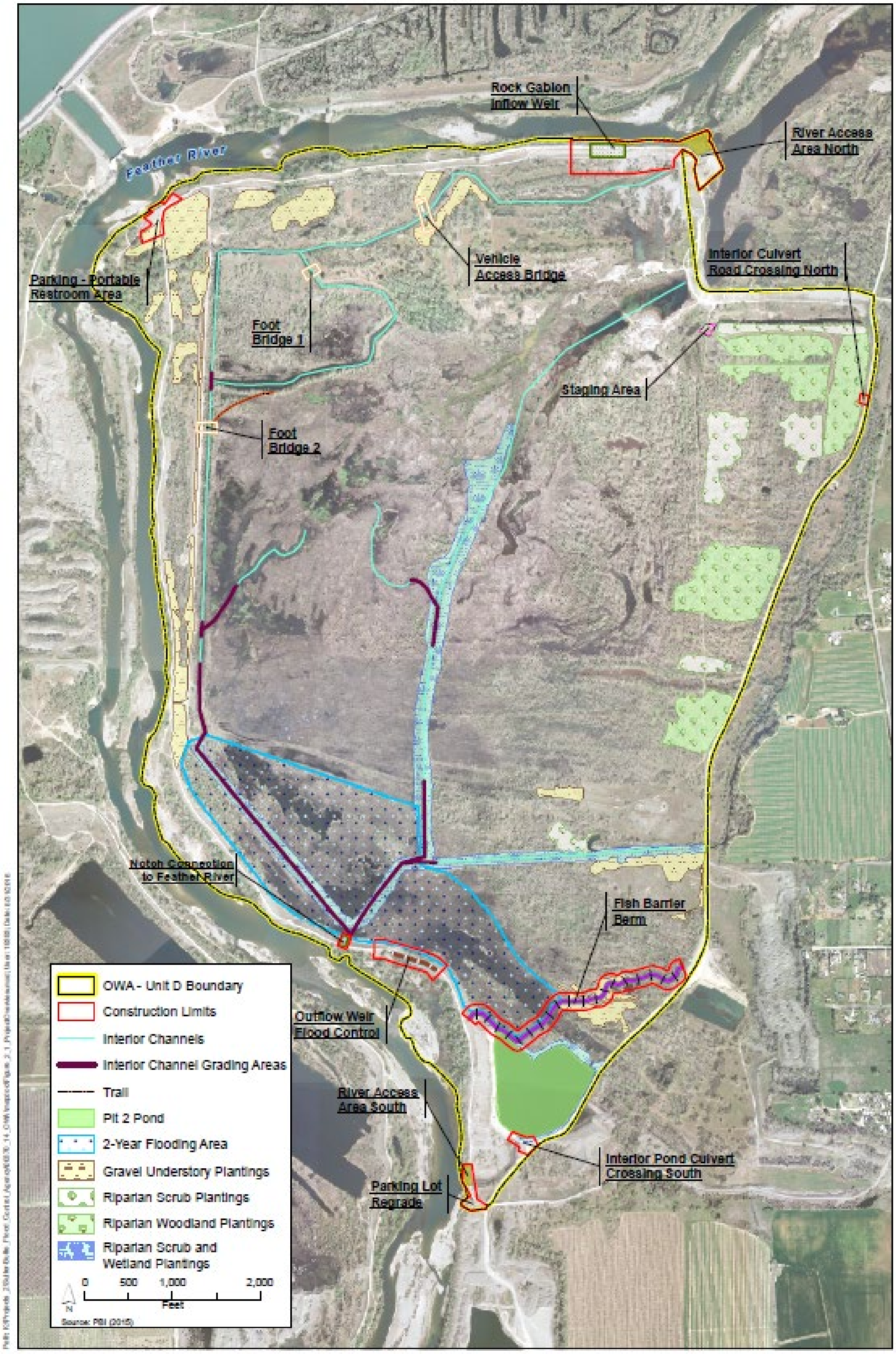

Figure 2. Action Area map and overview of Proposed Actions.

Vegetation management and restoration would include:

- Removal of approximately 500 acres of invasive water primrose (*Ludwigia peploides*) and approximately 200 acres of other invasive plant species.
- Mechanical or hand removal techniques are described in detail in the *Invasive Species Management Plan Oroville Wildlife Area D Unit* (CDFW 2016) and would be coordinated with chemical removal. Mechanical removal of invasive plant species would involve cutting and removal of invasive plants by hand or by machines. Hand crews would use clippers, loppers, weed wrenches, shovels, and chainsaws to pull or remove weeds. Machines such as backhoes, excavators, and brush hogs are desired in large areas with mature plants, especially where hand removal is infeasible.
- Installation of approximately 150 acres of riparian woodland plantings around the interior channels (approximately 70 acres of riparian woodland, 48 acres of riparian scrub and gravel understory plantings, and 32 acres of riparian scrub and wetland plantings).

Hydraulic improvements would include:

- Construction of a new approximately 400-foot-long rock gabion inflow weir (northeast boundary).
- Construction of a new notch connection to the Feather River (southwest boundary).
- Placement of rock fill along the existing outflow weir and installation of a concrete road crossing (southwest boundary).
- Construction of a fish barrier berm north of the Pit 2 pond (southern action area).
- Regrading sections of the existing interior channel system.
- Replacement of the existing culvert at the outlet of Pit 2 pond and installation of temporary culverts at the earthen road crossing near the channel outlet to the Feather River.
- Degrading of the existing Pit 2 pond berm, removal of the existing culvert, and installation of a concrete road crossing.

Recreation features would include:

- Regrading of the northern parking area across from the Thermalito Afterbay outlet.
- Regrading of the parking area south of the Pit 2 pond.
- Pouring of a new concrete pad for the existing portable restrooms across from the Thermalito Afterbay outlet.
- Construction of one emergency vehicle/footbridge channel crossing and two footbridge channel crossings.
- Grading of two river access areas (north and south).

1.3.2.1 Construction Schedule

Construction is anticipated to be completed in two seasons, with start and end dates of April 15 – November 1 each calendar year. The bulk of the work will be completed during first year and focus on the construction of hydraulic improvements, recreation enhancements, and vegetation management and restoration. Construction activities are expected to occur 6 days/week throughout the duration of the first year, with equipment clean up occurring on Sundays. Year 2 of construction is expected to require 120 total working days and will focus on vegetation management and restoration (*i.e.*, hand-removal treatment of invasive plant species and the continued planting of native riparian vegetation).

1.3.2.2 Rock Gabion Inflow Weir

A 400-foot-long rock gabion inflow weir would be constructed at the northeast end of the action area (Figure 2). The weir is essentially a notch in the existing berm that will allow more water from the Feather River to enter the OWA to reduce flood stages within the main channel of the Feather River. Prior to construction, the entire action area would be fenced along the construction limit. The area would then be cleared and grubbed before stripping away the top 6 inches of substrate. The existing berm would be degraded to an elevation of 130 feet above mean sea level. Stripped and degraded material may be spoiled onsite or hauled offsite for disposal. Gabion rock baskets and mattresses would be placed throughout the weir footprint, along the landside slope, and for 50 feet past the landside toe of the berm. Rock slope protection (RSP) would then be placed at either side of the weir. A new access road would be constructed using onsite fill material and would include two new ramps on the landside of the weir. An existing sewer line, owned and operated by the Sewerage Commission (Oroville Region), runs through the action area and would remain in place. Disturbed areas, excluding RSP and gabion mattresses/baskets, would be hydroseeded.

1.3.2.3 Construction of Notch Connections to the Feather River

A new permanent connection through the existing berm at the southeastern end of the unit would be constructed to connect the Feather River to the interior of the OWA (Figure 2). This connection would reconnect the river to its historic floodplain, address existing fish stranding concerns, and create seasonal floodplain habitat for juvenile salmonids and other fishes. The notch will provide a natural floodplain drainage point and egress route for juvenile salmonids during the receding limb of the hydrograph. Hydraulic modeling indicates that that the permanent connection would create approximately 150 acres, 400 acres, and 875 acres of shallow floodplain habitat during the historical 2-year, 3-year, and 6-year flow events, respectively. Larger events (100-year and larger) are not expected to change the maximum extent of inundation because water fully inundates the action area during such events under existing conditions; however, during all events, the proposed action is expected to improve floodplain rearing opportunities because of extended periods of floodplain inundation following recession of floodwaters.

The new connection would be a box culvert, or series of box culverts, with sluice gate(s) intended to allow backwater from the Feather River to enter the D-Unit and provide a route for fish to return to the river or enter the OWA over a broad range of flows. It is anticipated that box culverts would be prefabricated and lifted into place, followed by the construction of wing walls. Following construction, disturbed areas adjacent to the box culvert(s) and channel will be restored to pre-construction grades and hydroseeded.

Since grades along the interior of the OWA are lower than the Feather River, grading will be required to establish a permanent surface water connection between the OWA and Feather River. Below the OHWM, an area of approximately 162.5 x 175 feet (0.653 acre) will require grading (Figure 3). Prior to construction, the construction area would be fenced, cleared, and grubbed, with the top 6 inches of substrate being stripped off if necessary. Stripped material would be spoiled onsite or disposed of offsite. Grading would be completed to remove a portion of the existing berm.

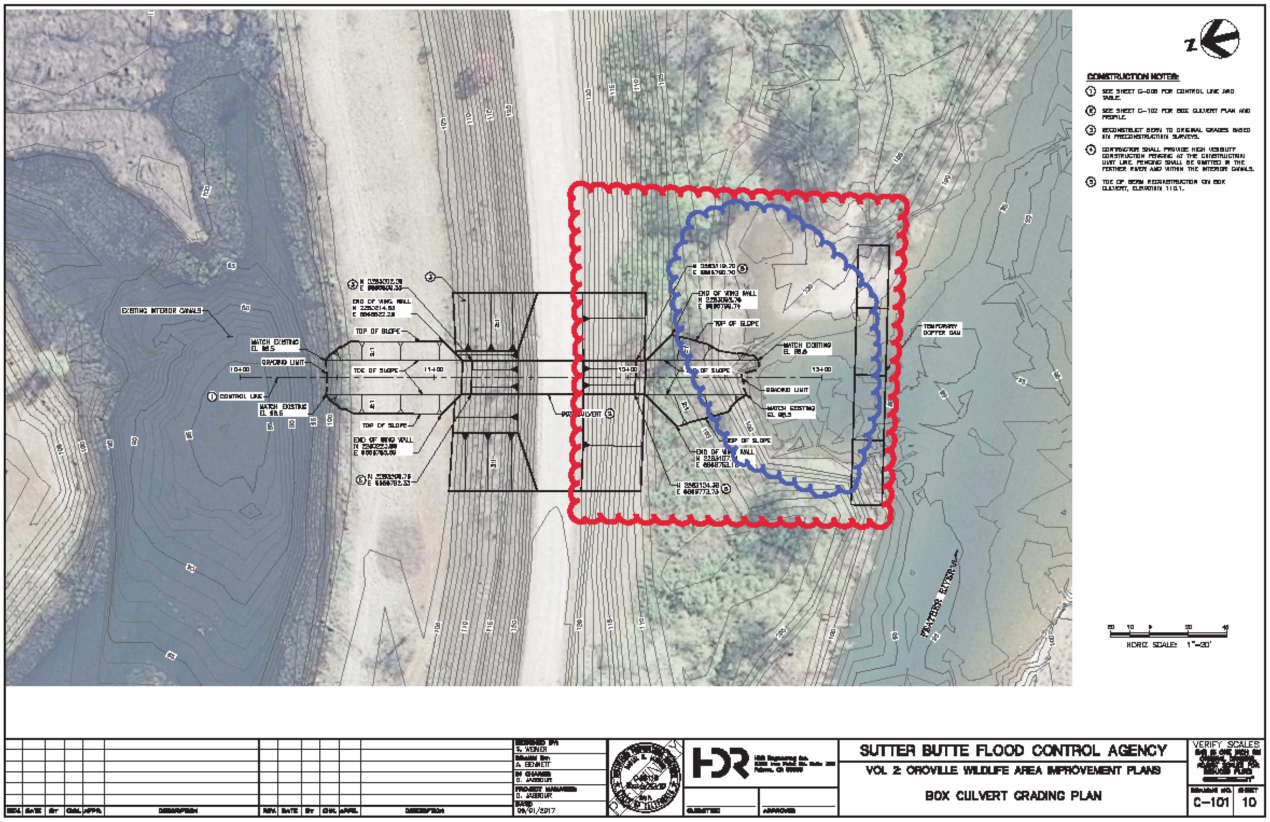

Figure 3. Overhead map of the notch construction site. The clouded red line on the waterside of the berm is the approximate footprint of the area below OHWM that will be graded to establish the notch connection. The clouded blue line represents the approximate area of the Feather River channel that will be dewatered during the installation of the cofferdam.

A temporary cofferdam of approximately 70 linear feet will be required to facilitate construction of the new channel and would be formed by steel sheet piles, earthen berms, or inflatable bladders. The blue line shown in Figure 3 delineates the approximate location of the area that will be dewatered by the cofferdam. The water is shallow here, approximately 5' deep or less. In the event that sheet piles are necessary, impact pile driving would be required due the presence of large cobble at the site. To install the cofferdam, approximately forty 30-inch sheet piles will be driven 20 feet into the riverbank. Depending on pile type, pile hammer size and type, subsurface conditions and the contractor's expertise, roughly 60 to 120 strikes per pile may be required. At a maximum, the contractor expects to be able to drive twenty piles per day. The action agency is assuming a 10-hour workday with an hour off for lunch, which leaves 540 minutes of work time per day. Dividing that time by the maximum number of piles (20 piles/day) gives us approximately 27 minutes per pile. We can assume 10-20 minutes of pile driving time (average of 15 minutes), leaving 12 minutes between the driving of each pile. Installation of the sheet piles would be discontinuous and would potentially occur for up to 4 days (total pile driving time, including periods of non-operation) depending on subsurface conditions.

1.3.2.4 Improvement of Outflow Weir Flood Control

The existing sheet pile outflow weir would be improved by placing RSP along the northern and southern sides of the sheet pile wall and a concrete access road along the northern side of the sheet pile wall. The RSP would be keyed into existing grade and would match the elevations of the tops of existing sheet pile walls. The concrete access road would be constructed at grade and may incorporate the use of gabion mattresses or cobbles from within the OWA. Disturbed areas, excluding RSP and the concrete access road, would be hydroseeded.

1.3.2.5 Fish Barrier Berm

An approximately 3,000 linear-foot berm would be constructed along the north side of Pit 2 pond (Figure 2). The purpose of the new berm is to prevent fish access into the Pit 2 pond in the southern part of the action area, which has been identified as a fish-stranding hazard. The berm would also maintain existing wildlife habitat and recreational use of the Pit 2 pond. The berm would be constructed using borrow material obtained from within the OWA. The area would be fenced, cleared, and grubbed prior to the start of construction, with the top 6 inches of material stripped if necessary. Stripped material would be spoiled onsite or disposed of offsite. The berm would then be constructed with a 12-foot-wide crown and side slopes ranging from three horizontal to one vertical (3H:1H) to 5H:1H. Disturbed areas would be hydroseeded upon completion of berm improvements.

1.3.2.6 Interior Channel Grading Improvements

Approximately 7,500 linear feet of existing channels in the interior of the OWA would be graded to improve connectivity of the channel system to the Feather River (Figure 2). The purpose of the improvements is to connect isolated ponds to the existing interior channel system to convey floodwaters back to the main channel, reduce fish stranding and enhance fish passage, provide new fish rearing habitat, and reduce the establishment of invasive plant species.

Improvements would include removing high berms, grading channel margins to enhance shoreline and wetland habitat, and installing restoration plantings. Portions of the berms would remain in place to provide refugia for wildlife during flood events. Prior to start of construction, the area would be fenced, cleared, and grubbed, with the top 6 inches of material stripped if necessary. Stripped material may be spoiled onsite or disposed of offsite. Disturbed areas would be hydroseeded upon completion of construction.

1.3.2.7 Improvement of Interior Road Culvert Crossings

To address performance deficiencies of the current low flow outlet and culvert in the southwest corner of the OWA D-Unit, an existing 60-inch corrugated metal pipe (CMP) culvert and berm at the outlet of the Pit 2 pond will be removed and replaced with a hardened concrete road surface. The new road crossing will be constructed flush with the outlet channel to allow water to freely flow from the pond into the channel during high flow events. In addition, an existing 60-inch CMP culvert located on the outlet channel adjacent to the Feather River will be removed and replaced with three new temporary 72-inch CMP culverts. Prior to start of construction for each of these features, the area would be fenced, cleared, and grubbed, with the top 6 inches of material stripped if necessary. Stripped material would be spoiled onsite or disposed of offsite. Following construction, disturbed areas adjacent would be restored to pre-construction grades and hydroseeded.

1.3.3 Avoidance and Minimization Measures

The following proposed conservation measures will be implemented to avoid or minimize potential adverse effects on federally listed fish and wildlife species. Measures 1-3, 7, and 8 have specific features aimed at reducing impacts to federally listed fish species that are described in further detail:

1) Stormwater Pollution Prevention Plan (SWPPP)

SBFCA will prepare a site-specific SWPPP as required by the Central Valley Regional Water Quality Control Board (CVRWQCB). Best management practices (BMPs) will be incorporated into the erosion and sediment control plan to ensure that land disturbance activities do not cause erosion that would increase sedimentation in the Feather River. Construction activities will be conducted during the typical construction season to avoid ground disturbance during the rainy season and equipment and materials will be staged in areas that have already been disturbed.

2) Turbidity Monitoring Plan

SBFCA would prepare a turbidity monitoring plan for the proposed action, as required by the CVRWQCB. The plan would require SBFCA or its contractor to monitor turbidity to determine whether turbidity is being affected by in-water construction and ensure that construction does not result in a substantial rise in turbidity levels above ambient conditions, in accordance with turbidity objectives in the *Water Quality Control Plan for the California Regional Water Quality Control Board, Central Valley Region – The Sacramento River Basin and the San Joaquin River Basin* (CVRWQCB 2009). The monitoring program would include monitoring ambient turbidity conditions at least 200 feet upstream and 200 feet downstream of construction activities. Grab samples would be collected at a downstream location that is representative of the flow near the construction site. If construction is creating a visible sediment plume, the sample would represent the plume. During all in-water construction activities, samples would be collected hourly to ensure compliance. During all other construction activities, samples would be collected on a random weekly basis.

The Basin Plan contains turbidity objectives for the Sacramento River Basin that includes the Feather River in the action area. Specifically, the plan states that where natural turbidity is between 5 and 50 nephelometric turbidity units (NTUs), turbidity levels may not be elevated by 20% above ambient conditions. Where ambient conditions are between 50 and 100 NTUs, conditions may not be increased by more than 10 NTUs. (CVRWQCB 2016). If turbidity limits exceed Basin Plan objectives, construction-related activities will slow to a point that achieves the objectives. SBFCA will notify the CVRWQCB of the issue and provide an explanation of the cause.

3) Spill Prevention, Control, and Counter-Measure Plan

Before any construction activities begin, SBFCA or its contractor will develop and implement a spill prevention, control, and counter-measure plan (SPCCP) intended to prevent any discharge of oil into navigable waters or adjoining shorelines. The SPCCP will be implemented during construction to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances. Implementation of this measure will comply with state and Federal water quality regulations. SBFCA would review and approve the SPCCP before onset of construction activities and routinely inspect the construction area to verify that the measures specified in the SPCCP are properly implemented and maintained.

The SPCCP would describe spill sources and spill pathways in addition to the actions that would be taken in the event of a spill (*i.e.*, an oil spill from engine refueling would be immediately cleaned up with oil absorbents). The SPCCP would outline descriptions of containment facilities and practices such as doubled-walled tanks, containment berms, emergency shut-offs, drip pans, fueling procedures, and spill response kits. The SPCCP will be implemented during construction to minimize the potential for and effects from spills of hazardous, toxic, or petroleum substances. SBFCA would notify its contractors immediately if there is a non-compliance issue and would require compliance.

The Federal reportable spill quantity for petroleum products, as defined in 40 CFR §110, is any oil spill that results in one or more of the following: (1) violates applicable water quality standards, (2) causes a film or sheen on or discoloration of the water surface or adjoining shoreline, or (3) causes a sludge or emulsion to be deposited beneath the surface of the water or adjoining shorelines.

If a spill is reportable, the contractor's superintendent will notify SBFCA, and SBFCA will take action to contact the appropriate safety and cleanup crews to ensure that the SPCCP is followed. A written description of reportable releases must be submitted to the CVRWQCB. This submittal must contain a description of the release, including the type of material and an estimate of the amount spilled, the date of the release, an explanation of why the spill occurred, and a description of the steps taken to prevent and control future releases. The releases will be documented on a spill report form. If a reportable spill occurs and results determine that construction activities have adversely affected surface water or groundwater quality, a detailed analysis will be performed by a registered environmental assessor or professional engineer to identify the likely cause of contamination. This analysis will conform to American Society for Testing and Materials standards and will include recommendations for reducing or eliminating the source or mechanisms of contamination. Based on this analysis, SBFCA and its contractors will select and implement measures to control contamination, with a performance standard that surface water quality and groundwater quality must be returned to baseline conditions.

4) Conduct Mandatory Contractor/Worker Awareness Training for Construction Personnel

5) Exclusion Fencing around Sensitive Biological Resources

6) Retain a Biological Monitor

7) Protection and Relocation of Fishes in Dewatered Construction Zone

A qualified fish biologist will be onsite during the installation of cofferdams or other water barriers to remove trapped salmonids and other fishes prior to dewatering or construction activities within the isolated construction area. Fishes will be herded or captured and relocated to suitable habitat downstream of the work area. Protocols for the capture, handling, and release of fish will be developed in cooperation with NMFS and CDFW. Fish biologists will contact NMFS and CDFW immediately if any steelhead, Chinook salmon, white sturgeon, or green sturgeon are found alive, dead, or injured.

8) Implement Measures to Minimize Underwater Noise Levels during Pile Driving

If pile driving is required to install the cofferdams for the notch connection when listed fish species may be present, SBFCA will require the contractor to implement the following measures, developed in coordination with project design engineers, to minimize the potential for exposure of listed fish species to harmful underwater noise:

- If feasible, the contractor will vibrate all piles to the maximum depth possible before using an impact hammer.

- During impact pile driving, the contractor will limit the number of strikes to the minimum necessary to complete the work.

- The smallest pile driver and minimum force necessary will be used to complete the work.

- During impact pile driving, a qualified fish biologist will monitor the area surrounding the construction site for fishes exhibiting signs of distress.

- The fish biologist will contact NMFS and DFW immediately if any steelhead, Chinook salmon, or sturgeon are observed or found dead or injured during impact pile driving.

- No pile driving will occur at night.

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, Federal agencies must ensure that their 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 an opinion stating how the agency's actions would affect listed species and their critical habitat. If incidental take is expected, 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 and terms and conditions to minimize such impacts.

2.1 Analytical Approach

This opinion includes both a jeopardy analysis and 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 opinion 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).

The designations of critical habitat for species uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7414) 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 biological opinion, 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 a proposed action is likely to jeopardize listed species, or destroy or adversely modify critical habitat:

- Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.

- Describe the environmental baseline in the action area.

- Analyze the effects of the proposed action 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 proposed action poses to species and critical habitat.

- Reach a conclusion about whether species are jeopardized or critical habitat is adversely modified.

- If necessary, define a reasonable and prudent alternative to the proposed action.

2.2 Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that would be adversely affected by the proposed action. 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 (Table 1). 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.

Table 1. ESA listing history.

Species	ESU or DPS	Original Final FR Listing	Current Final Listing Status	Critical Habitat Designated
Chinook salmon (*Oncorhynchus tshawytscha)*	Central Valley spring-run ESU	9/16/1999 64 FR 50394 Threatened	6/28/2005 70 FR 37160 Threatened	9/2/2005 70 FR 52488
Steelhead (*O. mykiss*)	California Central Valley DPS	3/19/1998 63 FR 13347 Threatened	1/5/2006 71 FR 834 Threatened	9/2/2005 70 FR 52488
Green sturgeon (*Acipenser medirostris*)	Southern DPS	4/7/2006 71 FR 17757 Threatened	4/7/2006 71 FR 17757 Threatened	10/9/2009 74 FR 52300

The opinion also examines the condition of critical habitat throughout the designated area, evaluates the 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 value for the conservation of the listed species.

The most recent status reviews conducted by NMFS for CV spring-run Chinook salmon (NMFS 2016a), CCV steelhead (NMFS 2016b), and the sDPS of North American green sturgeon (NMFS 2015), and concluded that the species' status should remain as previously listed in 2005/2006 (81 FR 33468; May 26, 2016). The previous status reviews completed in 2011, also concluded that the species' status should remain as previously listed (NMFS 2011a, b, c).

2.2.1 Central Valley Spring-run Chinook Salmon

CV spring-run Chinook salmon were listed as threatened on September 16, 1999 (64 FR 50394). This ESU consists of spring-run Chinook salmon occurring in the Sacramento River basin. The Feather River Fish Hatchery (FRFH) spring-run Chinook salmon population has been included as part of the CV spring-run Chinook salmon ESU in the most recent modification of the CV spring-run Chinook salmon listing status on June 28, 2005 (70 FR 37160). Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR 52488), and includes the action area for the proposed project. It includes stream reaches of the Feather and Yuba rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the main stem of the Sacramento River from Keswick Dam through the Delta; and portions of the network of channels in the northern Delta.

Historically spring-run Chinook salmon were the second most abundant salmon run in the CV and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle reaches (1,000 to 6,000 feet) of the San Joaquin, American, Yuba, Feather, Sacramento, McCloud and Pit rivers, with smaller populations in most tributaries with sufficient habitat for over-summering adults (Stone 1874, Rutter 1904, Clark 1929). The CV Technical Review Team estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions (diversity groups) (Lindley *et al.* 2004). Of these 18 populations, only three extant populations currently exist (Mill, Deer, and Butte creeks on the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. All populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated. The northwestern California diversity group did not historically contain independent populations, and currently contains two or three populations that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence.

Construction of low elevation dams in the foothills of the Sierras on the Mokelumne, Stanislaus, Tuolumne, and Merced rivers, has thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American and Yuba rivers of the Sacramento River basin. However, observations in the last decade suggest that perhaps a naturally occurring population may persist in the Stanislaus and Tuolumne as well as the Yuba River (Franks 2015). Naturally-spawning populations of CV spring-run Chinook salmon are currently restricted to accessible reaches of the upper Sacramento River, Antelope Creek, Battle Creek, Beegum Creek, Big Chico Creek, Butte Creek, Clear Creek, Deer Creek, Feather River, Mill Creek, and the Yuba River (CDFG 1998).

The construction of Shasta and Keswick dams on the Sacramento River and Oroville Dam on the Feather River and subsequent blocking of upstream migration has eliminated the spatial separation between spawning fall-run and spring-run Chinook salmon (Lindley *et al.* 2007). Reportedly, spring-run Chinook salmon migrated to the upper Feather River and its tributaries from mid-March through the end of July (CDFG 1998). Fall-run Chinook salmon reportedly migrated later and spawned in lower reaches of the Feather River than spring-run Chinook salmon (Yoshiyama *et al.* 2001). The same pattern also likely exists on the Sacramento River. Restricted access to historic spawning grounds currently causes spring-run Chinook salmon to spawn in the same lowland reaches that fall-run Chinook salmon use as spawning habitat. The overlap in spawning site locations, combined with an overlap in spawning timing (Moyle 2002) with temporally adjacent runs, is responsible for interbreeding between spring-run and fall-run Chinook salmon in the lower Feather River (Hedgecock *et al.* 2001) and in the Sacramento River below Keswick Dam. In the upper Sacramento River, lower Feather River, and lower Yuba River, spring-run Chinook salmon spawning may occur a few weeks earlier than fall-run spawning, but currently there is no clear distinction between the two because of the disruption of spatial segregation by Shasta and Keswick dams on the Sacramento River, Oroville Dam on the Feather River, and Englebright Dam on the Yuba River. Thus, spring-run and fall-run Chinook salmon spawning overlap temporally and spatially.

This presents difficulties from a management perspective in determining the proportional contribution of total spawning escapement by the spring- and fall-runs. Because of unnaturally high densities of spawning, particularly in the in the low flow channel (LFC) of the Feather River, spawning habitat is likely a limiting factor. Intuitively, it could be inferred that the slightly earlier spawning Chinook salmon displaying spring-run behavior would have better access to the limited spawning habitat, although early spawning likely leads to a higher rate of redd superimposition. Redd superimposition occurs when spawning Chinook salmon dig redds on top of existing redds dug by other Chinook salmon. The rate of superimposition is a function of spawning densities and typically occurs in systems where spawning habitat is limited (Fukushima *et al.* 1998). Redd superimposition may disproportionately affect early spawners and, therefore, potentially affect Chinook salmon exhibiting spring-run life history characteristics salmon (Lindley *et al.* 2007).

The distribution and timing of CV spring-run Chinook salmon varies depending on the life stage, and is shown below (Table 2).

Table 2. The temporal occurrence of adult (a) and juvenile (b) Central Valley spring-run Chinook salmon in the Sacramento River. Darker shades indicate months of greatest relative abundance.

(a) Adult migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River basin[a,b]					▓	▓	▓	▓	■	■	■	■	▓	▓	▓	▓	▓	▓	░					
Sac. River Mainstem[b,c]		░	░	░	▓	▓	▓	▓	▓	▓	▓	▓	▓	▓	░	░								
Mill Creek[d]					░	░	▓	■	■	■	■	▓	▓	░	░									
Deer Creek[d]					░	░	▓	■	■	■	■	▓	▓											
Butte Creek[d,g]			░	▓	▓	▓	▓	■	■	■	■	▓	░											
(b) Adult Holding[a,b]				░	░	▓	▓	■	■	■	■	■	■	■	■	▓	▓	░	░					
(c) Adult Spawning[a,b,c]															░	▓	■	■	▓	░				
(d) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
Sac. River Tribs[e]	▓	▓	▓	▓	▓	▓													▓	▓	■	■	■	■
Upper Butte Creek[f,g]	■	■	■	■	▓	▓	▓	▓	▓	▓	░	░							░	░	░	░	■	■
Mill, Deer, Butte Creeks[d,g]	■	■	■	■	▓	▓	▓	▓	▓	▓	░	░							░	░	░	░	░	░
Sac. River at RBDD[c]	■	■	░	░	░	░	░	░	░												■	■	■	■
Sac. River at KL[h]	▓	▓	▓	▓	■	■	■	■	▓	▓											▓	▓	■	■

Relative Abundance: ■ = High ▓ = Medium ░ = Low

2.2.1.1 Critical Habitat: Physical and Biological Features for CV Spring-Run Chinook Salmon

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, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches (70 FR 52488; September 2, 2005) and the lateral extent as defined by the ordinary high-water line (OHWM). In areas where the OHWM has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of one to two years on the annual flood series) (Bain &

Stevenson 1999; 70 FR 52488). Critical habitat for CV spring-run Chinook salmon is defined as specific areas that contain the PBFs essential to the conservation of the species. Following are the inland habitat types used as PBFs for CV spring-run Chinook salmon.

Spawning Habitat

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most spawning habitat in the CV for Chinook salmon is located in areas directly downstream of dams containing suitable environmental conditions for spawning and incubation. Spawning habitat for CV spring-run Chinook salmon occurs on the mainstem Sacramento River between Red Bluff Diversion Dam (RBDD) and Keswick Dam and in tributaries such as Mill, Deer, and Butte creeks; as well as the Feather and Yuba rivers, and Big Chico, Battle, Antelope, and Clear creeks. However, little spawning activity has been recorded in recent years on the Sacramento River mainstem for spring-run Chinook salmon. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

Freshwater Rearing Habitat

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large woody material (LWM), log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from piscivorous fish and birds. Freshwater rearing habitat also has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks, which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream passage of adults and the downstream emigration of juveniles. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For adults, upstream passage through the Delta and much of the Sacramento River is not a problem, yet a number of challenges exist on many tributary streams. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a scarcity of complex in-river cover have degraded this PBF. However, since the primary migration corridors are used by numerous populations and are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic conservation value to the species.

Estuarine Areas

This PBF is outside of the action area for the proposed action. The remaining estuarine habitat for these species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

2.2.1.2 Description of VSP Parameters

Abundance

The Central Valley drainage as a whole is estimated to have supported spring-run Chinook salmon runs as large as 600,000 fish between the late 1880s and 1940s (CDFG 1998). The San Joaquin River historically supported a large run of spring-run Chinook salmon, suggested to be one of the largest runs of any Chinook salmon on the West Coast with estimates averaging 200,000 – 500,000 adults returning annually (CDFG 1990). Construction of Friant Dam on the San Joaquin River began in 1939, and when completed in 1942, blocked access to all upstream habitat.

The FRFH spring-run Chinook salmon population represents a remaining evolutionary legacy of the spring-run Chinook salmon populations that once spawned above Oroville Dam, and has been included in the ESU based on its genetic linkage to the natural spawning population, and the potential development of a conservation strategy, for the hatchery program. Abundance from 1993 to 2004 were consistently over 4,000 (averaging nearly 5,000), while 2005 to 2014 were lower, averaging just over 2,000 (CDFW Grandtab 2015).

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates some spawning occurs in the river. Here, the lack of physical separation of spring-run Chinook salmon from fall-run Chinook salmon is complicated by overlapping migration and spawning periods. Significant hybridization with fall-run Chinook salmon makes identification of spring-run Chinook salmon in the mainstem difficult to determine, but counts of

Chinook salmon redds in September are typically used as an indicator of spring-run Chinook salmon abundance. Redd surveys conducted in September between 2001 and 2011 have observed an average of 36 Chinook salmon redds from Keswick Dam downstream to the RBDD, ranging from 3 to 105 redds; in 2012 zero redds were observed, and in 2013, 57 redds were observed in September 2014 (CDFW 2015). Therefore, even though physical habitat conditions can support spawning and incubation, spring-run Chinook salmon depend on spatial segregation and geographic isolation from fall-run Chinook salmon to maintain genetic diversity. With the onset of fall-run Chinook salmon spawning occurring in the same time and place as potential spring-run Chinook salmon spawning, it is likely extensive introgression between the populations has occurred (CDFG 1998). For these reasons, Sacramento River mainstem spring-run Chinook salmon are not included in the following discussion of ESU abundance trends.

For many decades, CV spring-run Chinook salmon were considered extirpated from the Southern Sierra Nevada diversity group in the San Joaquin River Basin, despite their historical numerical dominance in the Basin (Fry 1961, Fisher 1994). More recently, there have been reports of adult Chinook salmon returning in February through June to San Joaquin River tributaries, including the Mokelumne, Stanislaus, and Tuolumne rivers (Franks 2014, Workman 2003, FishBio 2015). These spring-running adults have been observed in several years and exhibit typical spring-run life history characteristics, such as returning to tributaries during the springtime, over-summering in deep pools, and spawning in early fall (Franks 2014, Workman 2003, FishBio 2015). For example, 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only seven individuals without adipose fins (FishBio 2015).

Additionally, in 2014, implementation of the spring-run Chinook salmon reintroduction plan into the San Joaquin River has begun, which if successful will benefit the spatial structure, and genetic diversity of the ESU. These reintroduced fish have been designated as a nonessential experimental population under ESA Section 10(j) when within the defined boundary in the San Joaquin River (78 FR 79622; December 31, 2013). Furthermore, while the San Joaquin River Restoration Project (SJRRP) is managed to imprint CV spring-run Chinook salmon to the mainstem San Joaquin River, we do anticipate that the reintroduced spring-run Chinook salmon are likely to stray into the San Joaquin tributaries at some level, which will increase the likelihood for CV spring-runChinook salmon to repopulate other Southern Sierra Nevada diversity group rivers where suitable conditions exist.

Sacramento River tributary populations in Mill, Deer, and Butte creeks are likely the best trend indicators for the CV spring-run Chinook salmon ESU as a whole because these streams contain the majority of the abundance, and are currently the only independent populations within the ESU. Generally, these streams have shown a positive escapement trend since 1991, displaying broad fluctuations in adult abundance, ranging from 1,013 in 1993 to 23,788 in 1998. Escapement numbers are dominated by Butte Creek returns, which averaged over 7,000 fish from 1995 to 2005, but then declined in years 2006 through 2011 with an average of just over 3,000 (although 2008 was nearly 15,000 fish). During this same period, adult returns on Mill and Deer creeks have averaged over 2,000 fish total and just over 1,000 fish total, respectively. From 2001 to 2005, the CV spring-run Chinook salmon ESU experienced a trend of increasing abundance in some natural populations, most dramatically in the Butte Creek population (Good *et al.* 2005).

Additionally, in 2002 and 2003, mean water temperatures in Butte Creek exceeded 21ºC for 10 or more days in July (Williams 2006). These persistent high water temperatures, coupled with high fish densities, precipitated an outbreak of Columnaris (*Flexibacter columnaris*) and Ichthyophthiriasis (*Ichthyophthirius multifiis*) diseases in the adult spring-run Chinook salmon over-summering in Butte Creek. In 2002, this contributed to a pre-spawning mortality of approximately 20 to 30 percent of the adults. In 2003, approximately 65 percent of the adults succumbed, resulting in a loss of an estimated 11,231 adult spring-run Chinook salmon in Butte Creek due to the diseases. In 2015, Butte Creek again experienced severe temperature conditions, with nearly 2,000 fish entering the creek, only 1,081 observed during the snorkel survey, and only 413 carcasses observed, which indicates a large number of pre-spawn mortality.

Declines in abundance from 2005 to 2011, placed the Mill Creek and Deer Creek populations in the high extinction risk category due to the rates of decline, and in the case of Deer Creek, also the level of escapement (NMFS 2011a). Butte Creek has sufficient abundance to retain its low extinction risk classification, but the rate of population decline in years 2006 through 2011 was nearly sufficient to classify it as a high extinction risk based on this criteria. Nonetheless, the watersheds identified as having the highest likelihood of success for achieving viability/low risk of extinction include Butte, Deer and Mill creeks (NMFS 2011a). Some other tributaries to the Sacramento River, such as Clear Creek and Battle Creek have seen population gains in the years from 2001 to 2009, but the overall abundance numbers have remained low. 2012 appeared to be a good return year for most of the tributaries with some, such as Battle Creek, having the highest return on record (799). Additionally, 2013 escapement numbers increased, in most tributary populations, which resulted in the second highest number of spring-run Chinook salmon returning to the tributaries since 1998. However, 2014 abundance was lower, with just over 5,000 fish for the tributaries combined, which indicates a highly fluctuating and unstable ESU abundance. Even more concerning was returns for 2015, which were record lows for some populations. In the next several years, numbers are anticipated to remain quite low as the effects of the 2012-2015 drought are fully realized.

Productivity

The productivity of a population (*i.e.,* production over the entire life cycle) can reflect conditions (*e.g.,* environmental conditions) that influence the dynamics of a population and determine abundance. In turn, the productivity of a population allows an understanding of the performance of a population across the landscape and habitats in which it exists and its response to those habitats (McElhany *et al.* 2000). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000) suggested criteria for a population's natural productivity should be sufficient to maintain its abundance above the viable level (a stable or increasing population growth rate). In the absence of numeric abundance targets, this guideline is used. Cohort replacement rates (CRR) are indications of whether a cohort is replacing itself in the next generation.

From 1993 to 2007 the 5-year moving average of the CV spring-run Chinook salmon tributary population CRR remained over 1.0, but then declined to a low of 0.47 in years 2007 through

2011 (Table 3). The productivity of the Feather River and Yuba River populations and contribution to the CV spring-run Chinook salmon ESU currently is unknown; however, the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.84, and 8.68 in 2013, due to increases in abundance for most populations. Although 2014 returns were lower than the previous two years, the CRR was still positive (1.85). However, 2015 returns were very low, with a CRR of 0.14, when using Butte Creek snorkel survey numbers, the lowest on record. Using the Butte Creek carcass surveys, the 2015 CRR for just Butte Creek was only 0.02.

Table 3. Central Valley Spring-run Chinook salmon population estimates from CDFW Grand Tab (2015) with corresponding cohort replacement rates for years since 1986.

capement

Year	Sacramento River Basin Escapement Run Size[a]	FRFH Population	Tributary Populations	5-Year Moving Average Tributary Population Estimate	Trib CRR[b]	5-Year Moving Average of Trib CRR	5-Year Moving Average of Basin Population Estimate	Basin CRR	5-Year Moving Average of Basin CRR
1986	3,638	1,433	2,205						
1987	1,517	1,213	304						
1988	9,066	6,833	2,233						
1989	7,032	5,078	1,954		0.89			1.93	
1990	3,485	1,893	1,592	1,658	5.24		4,948	2.30	
1991	5,101	4,303	798	1,376	0.36		5,240	0.56	
1992	2,673	1,497	1,176	1,551	0.60		5,471	0.38	
1993	5,685	4,672	1,013	1,307	0.64	1.55	4,795	1.63	1.22
1994	5,325	3,641	1,684	1,253	2.11	1.79	4,454	1.04	1.18
1995	14,812	5,414	9,398	2,814	7.99	2.34	6,719	5.54	1.83
1996	8,705	6,381	2,324	3,119	2.29	2.73	7,440	1.53	2.03
1997	5,065	3,653	1,412	3,166	0.84	2.77	7,918	0.95	2.14
1998	30,533	6,746	23,787	7,721	2.53	3.15	12,888	2.06	2.23
1999	9,838	3,731	6,107	8,606	2.63	3.26	13,791	1.13	2.24
2000	9,201	3,657	5,544	7,835	3.93	2.44	12,669	1.82	1.50
2001	16,865	4,135	12,730	9,916	0.54	2.09	14,300	0.55	1.30
2002	17,212	4,189	13,023	12,238	2.13	2.35	16,730	1.75	1.46
2003	17,691	8,662	9,029	9,287	1.63	2.17	14,161	1.92	1.43
2004	13,612	4,212	9,400	9,945	0.74	1.79	14,916	0.81	1.37
2005	16,096	1,774	14,322	11,701	1.10	1.23	16,295	0.94	1.19
2006	10,828	2,061	8,767	10,908	0.97	1.31	15,088	0.61	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,591	0.71	1.00
2008	6,162	1,418	4,744	8,857	0.33	0.78	11,285	0.38	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,323	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.53	6,862	0.39	0.49
2011	5,033	1,969	3,064	3,961	0.65	0.47	5,703	0.82	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,702	3.87	1.16
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	4.85	2.06
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.68	2.32
2015	3,074	1,586	1,488	7,057	0.14	2.63	9,930	0.21	2.28
Median	9,775	3,616	6,159	6,541	1.97	1.89	10,220	1.00	1.46

[a] NMFS is only including the escapement numbers from the Feather River Fish Hatchery (FRFH) and the Sacramento River tributaries in this table. Sacramento River Basin run size is the sum of the escapement numbers from the FRFH and the tributaries. [b] Abbreviations: CRR = Cohort Replacement Rate, Trib = tributary

Spatial Structure

Spatial structure refers to the arrangement of populations across the landscape, the distribution of spawners within a population, and the processes that produce these patterns. Species with a restricted spatial distribution and few spawning areas are at a higher risk of extinction from catastrophic environmental events (*e.g.*, a single landslide) than are species with more widespread and complex spatial structure. Species or population diversity concerns the phenotypic (morphology, behavior, and life-history traits) and genotypic (DNA) characteristics of populations. Phenotypic diversity allows more populations to use a wider array of environments and protects populations against short-term temporal and spatial environmental changes. Genotypic diversity, on the other hand, provides populations with the ability to survive long-term changes in the environment. To meet the objective of representation and redundancy, diversity groups need to contain multiple populations to survive in a dynamic ecosystem subject to unpredictable stochastic events, such as pyroclastic events or wild fires.

The Central Valley Technical Review Team estimated that historically there were 18 or 19 independent populations of CV spring-run Chinook salmon, along with a number of dependent populations, all within four distinct geographic regions, or diversity groups (Figure 3) (Lindley *et al.* 2004). Of these populations, only three independent populations currently exist (Mill, Deer, and Butte creeks tributary to the upper Sacramento River) and they represent only the northern Sierra Nevada diversity group. Additionally, smaller populations are currently persisting in Antelope and Big Chico creeks, and the Feather and Yuba rivers in the northern Sierra Nevada diversity group (CDFG 1998).

Most historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated; Battle Creek in the basalt and porous lava diversity group has had a small persistent population in Battle Creek since 1995, and the upper Sacramento River may have a small persisting population spawning in the river mainstem as well. The northwestern California diversity group did not historically contain independent populations, and currently contains two small persisting populations, in Clear Creek, and Beegum Creek (tributary to Cottonwood Creek) that are likely dependent on the northern Sierra Nevada diversity group populations for their continued existence. Construction of low elevation dams in the foothills of the Sierras on the San Joaquin, Mokelumne, Stanislaus, Tuolumne, and Merced rivers, has thought to have extirpated CV spring-run Chinook salmon from these watersheds of the San Joaquin River, as well as on the American River of the Sacramento River basin. However, observations in the last decade suggest that perhaps spring-running populations may currently occur in the Stanislaus and Tuolumne rivers (Franks 2014).

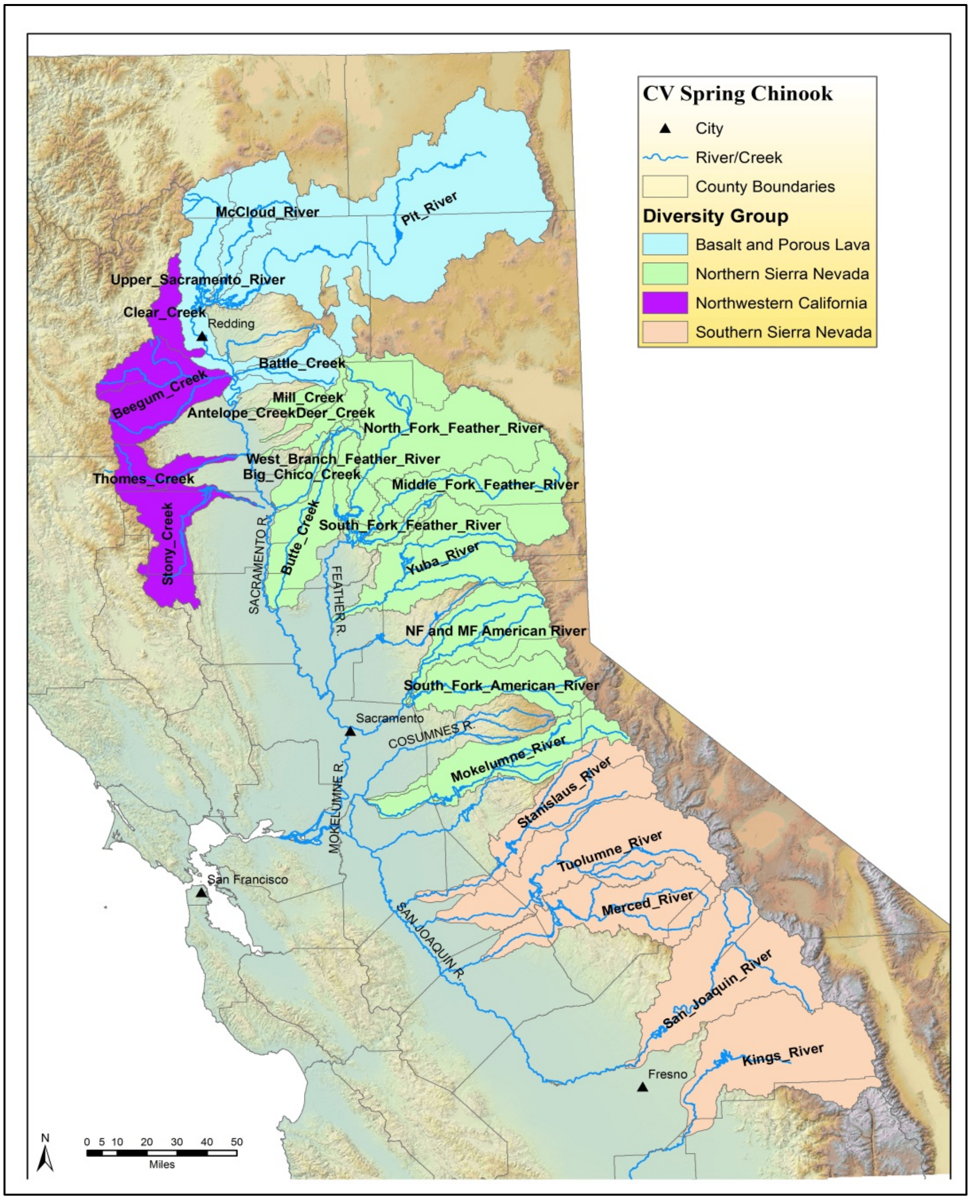

Figure 4. Diversity Groups for the Central Valley spring-run Chinook salmon ESU.

With only one of four diversity groups currently containing independent populations, the spatial structure of CV spring-run Chinook salmon is severely reduced. Butte Creek spring-run Chinook salmon adult returns are currently utilizing all available habitat in the creek; and it is unknown if individuals have opportunistically migrated to other systems. The persistent populations in Clear Creek and Battle Creek, with habitat restoration projects completed and more underway, are anticipated to add to the spatial structure of the CV spring-run Chinook salmon ESU if they can reach viable status in the basalt and porous lava and northwestern California diversity group areas. The spatial structure of the spring-run Chinook salmon ESU would still be lacking due to the extirpation of all San Joaquin River basin spring-run Chinook salmon populations; however, recent information suggests that perhaps a self-sustaining population of spring-run Chinook salmon is occurring in some of the San Joaquin River tributaries, most notably the Stanislaus and the Tuolumne rivers.

A final rule was published to designate a nonessential experimental population of CV spring-run Chinook salmon to allow reintroduction of the species below Friant Dam on the San Joaquin River as part of the SJRRP (78 FR 79622; December 31, 2013). Pursuant to ESA Section 10(j), with limited exceptions, each member of an experimental population shall be treated as a threatened species. The rule includes protective regulations under ESA section 4(d) that provide specific exceptions to prohibitions for taking CV spring-run Chinook salmon within the experimental population area, and in specific instances elsewhere. The first release of CV spring-run Chinook salmon juveniles into the San Joaquin River occurred in April, 2014. Releases have continued annually during the spring. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined.

Snorkel surveys (Kennedy & Cannon 2005) conducted between October 2002 to October 2004 on the Stanislaus River identified adults in June 2003 and 2004, as well as observed Chinook fry in December of 2003, which would indicate spring-run Chinook salmon spawning timing. In addition, monitoring on the Stanislaus since 2003 and on the Tuolumne since 2009 has indicated upstream migration of adult spring-run Chinook salmon (Anderson *et al.* 2007), and 114 adult were counted on the video weir on the Stanislaus River between February and June in 2013 with only 7 individuals without adipose fins (FishBio 2015). Finally, rotary screw trap data provided by Stockton U.S. Fish and Wildlife Service (USFWS) corroborates the spring-run Chinook salmon adult timing, by indicating that there are a small number of fry migrating out of the Stanislaus and Tuolumne at a period that would coincide with spring-run juvenile emigration (Franks 2014). Although there have been observations of springtime running Chinook salmon returning to the San Joaquin tributaries in recent years, there is insufficient information to determine the specific origin of these fish, and whether or not they are straying into the basin or returning to natal streams. Genetic assessment or natal stream analyses of hard tissues could inform our understanding of the relationship of these fish to the ESU.

Lindley *et al.* (2007) described a general criteria for "representation and redundancy" of spatial structure, which was for each diversity group to have at least two viable populations. More specific recovery criteria for the spatial structure of each diversity group have been laid out in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014). According to the criteria, one viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group, in addition to maintaining dependent populations, are needed for recovery. It is clear that further efforts will need to involve more than restoration of currently accessible watersheds to make the ESU viable. The NMFS Central Valley Salmon and Steelhead Recovery Plan calls for reestablishing populations into historical habitats currently blocked by large dams, such as the reintroduction of a population upstream of Shasta Dam, and to facilitate passage of fish upstream of Englebright Dam on the Yuba River (NMFS 2014).

Diversity

Diversity, both genetic and behavioral, is critical to success in a changing environment. Salmonids express variation in a suite of traits, such as anadromy, morphology, fecundity, run timing, spawn timing, juvenile behavior, age at smolting, age at maturity, egg size, developmental rate, ocean distribution patterns, male and female spawning behavior, and physiology and molecular genetic characteristics (including rate of gene-flow among populations). Criteria for the diversity parameter are that human-caused factors should not alter variation of traits. The more diverse these traits (or the more these traits are not restricted), the more adaptable a population is, and the more likely that individuals, and therefore the species, would survive and reproduce in the face of environmental variation (McElhany *et al.* 2000). However, when this diversity is reduced due to loss of entire life history strategies or to loss of habitat used by fish exhibiting variation in life history traits, the species is in all probability less able to survive and reproduce given environmental variation.

The CV spring-run Chinook salmon ESU is comprised of two known genetic complexes. Analysis of natural and hatchery CV spring-run Chinook salmon stocks in the Central Valley indicates that the northern Sierra Nevada diversity group spring-run Chinook salmon populations in Mill, Deer, and Butte creeks retain genetic integrity as opposed to the genetic integrity of the Feather River population, which has been somewhat compromised. The Feather River spring-run Chinook salmon have introgressed with the Feather River fall-run Chinook salmon, and it appears that the Yuba River spring-run Chinook salmon population may have been impacted by FRFH fish straying into the Yuba River (and likely introgression with wild Yuba River fall-run has occurred). Additionally, the diversity of the spring-run Chinook salmon ESU has been further reduced with the loss of the majority if not all of the San Joaquin River basin spring-run Chinook salmon populations. Efforts like the SJRRP, to reintroduce a spring-run population below Friant Dam, which are underway, are needed to improve the diversity of CV spring-run Chinook salmon.

Summary of ESU Viability

Since the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley *et al.* (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of extinction in Butte and Deer creeks, according to their population viability analysis (PVA) model and other population viability criteria (*i.e.*, population size, population decline, catastrophic events, and hatchery influence, which correlate with VSP parameters abundance, productivity, spatial structure, and diversity). The Mill Creek population of spring-run Chinook salmon was at moderate extinction risk according to the PVA model, but appeared to satisfy the other viability criteria for low-risk status. However, the CV spring-run Chinook salmon ESU failed to meet the “representation and redundancy rule” since there are only demonstrably viable populations in one diversity group (northern Sierra Nevada) out of the three diversity groups that historically contained them, or out of the four diversity groups as described in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014). Over the long term, these three remaining populations are considered to be vulnerable to catastrophic events, such as volcanic eruptions from Mount Lassen or large forest fires due to the close proximity of their headwaters to each other.

In 2012 and 2013, most tributary populations increased in returning adults, averaging over 13,000. However, 2014 returns were lower again, just over 5,000 fish, indicating the ESU remains highly fluctuating. The most recent status review conducted in 2015 (NMFS 2016a) looked at promising increasing populations in 2012-2014; however, the 2015 returning fish were extremely low (1,488), with additional pre-spawn mortality reaching record highs.

The recent drought impacts on Butte Creek can be seen from the lethal water temperatures in traditional and non-traditional spring-run Chinook salmon holding habitat during the summer. Pre-spawn mortality was observed during the 2007 to 2009 drought with an estimate of 1,054 adults dying before spawning (Garman 2015, *pers. comm.*). A large number of adults (903 and 232) also were estimated to have died prior to spawning in the 2013 and 2014 drought, respectively (Garman 2015, *pers. comm.*). In 2015, late arriving adults in the Chico vicinity experienced exceptionally warm June air temperatures coupled with the PG&E flume shutdown resulting in a fish die off. Additionally, adult spring-run Chinook salmon in Mill, Deer, and Battle creeks were exposed to warm temperatures, and pre-spawn mortality was observed. Thus, while the independent CV spring-run Chinook populations have generally improved since 2010, and are considered at moderate (Mill and Deer) or low (Butte Creek) risk of extinction, these populations are likely to deteriorate over the next three years due to drought impacts, which may in fact result in severe declines.

In summary, the status of the CV spring-run Chinook salmon ESU, until 2015, has probably improved since the 2010 status review. The largest improvements are due to extensive restoration, and increases in spatial structure with historically extirpated populations trending in the positive direction. Improvements, evident in the moderate and low risk of extinction of the three independent populations, however, are certainly not enough to warrant the delisting of the ESU. The recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2015 drought, uncertain juvenile survival during the drought, and ocean conditions, as well as the level of straying of FRFH spring-run Chinook salmon to other CV spring-run Chinook salmon populations are all causes for concern for the long-term viability of the CV spring-run Chinook salmon ESU.

2.2.2 California Central Valley Steelhead

CCV steelhead were listed as threatened on March 19, 1998, (63 FR 13347). In classifying the threatened listing of CCV steelhead DPS, NMFS highlighted the historical loss and degradation of spawning and rearing habitat as one of the major factors leading to the current low population abundances. This habitat loss and degradation is due to a combination of water development projects and operations that include, but are not limited to: (1) impassable dams, water diversions, and hydroelectric operations on almost every major river in the Central Valley; (2) antiquated fish screens, fish ladders, and diversion dams on streams throughout the Sacramento River Basin; and (3) levee construction and maintenance projects that do not incorporate fish-friendly designs. All of those projects and operations reduce the habitat quality and/or quantity for steelhead. The massive alterations to river channels from the gold mining era continue to impact aquatic habitats throughout much of the Central Valley. Busby *et al.* (1996) cited other land use practices that have degraded steelhead habitat in the Central Valley including forestry, agriculture, and urbanization of watersheds.

Good *et al.* (2005) described the threats to Central Valley salmon and steelhead as falling into three broad categories: loss of historical spawning habitat, degradation of remaining habitat, and genetic threats from the stocking programs. Cummins *et al.* (2008) attributed the much reduced biological status of Central Valley anadromous salmonid stocks to the construction and operation of the CVP and SWP:

> *"Construction and operation of the CVP and SWP have altered flows, reduced water quality, and degraded environmental conditions and reduced habitat for fish and wildlife in the Central Valley from the headwaters to the Delta. This includes the native anadromous fish of the Central Valley -- winter, spring, fall and late-fall chinook, steelhead and sturgeon. Adult runs that once numbered in the millions have been reduced to thousands or less.*
>
> *The transformation of the natural Sacramento/San Joaquin river systems into a massive water storage and delivery system includes dams and diversions that have blocked access for anadromous salmonids to much of their historical habitat. Development of the CVP and SWP has significantly modified the natural hydrologic, geomorphic, physical and biological systems. The modified river system significantly impacts the native salmon and steelhead production as a result of fragmented habitats, migration barriers, and seasonally altered flow and habitat regimes."*

However, in the last 5-10 years, some habitat restoration programs and conservation plans have been implemented that, in aggregate, should provide a benefit to the habitat of Central Valley steelhead, or are expected to do so in the future.

The Central Valley experienced a severe drought during 2012 through 2015, which likely reduced the already limited habitat quality and range for CCV steelhead during this period. The very low numbers of adults seen at the Nimbus Fish Hatchery during the last few years may be related to the drought, as water temperatures in the lower American River at Hazel Avenue reached the low 70's (°F), well above the 65°F limit set in the NMFS 2009 opinion on the long-term operations of the Central Valley Project and State Water Project (OCAP), likely impacting survival of wild steelhead parr. Steelhead populations in the Central Valley historically dealt with periodic drought. The concern is that at current low levels of abundance and productivity, some populations may go extinct during long dry spells, and the re-establishment of these populations may be difficult due to the degraded habitat conditions.

There are indications that natural production of steelhead continues to decline and is now at very low levels. Their continued low numbers in most hatcheries, domination by hatchery fish, and relatively sparse monitoring makes the continued existence of naturally reproduced steelhead a concern. The most recent 5-year status review completed by NMFS recommends that CCV steelhead remain listed as threatened, as the DPS is likely to become endangered within the foreseeable future throughout all or a significant portion of its range (NMFS 2016b).

The distribution and timing of steelhead varies depending on the life stage, and is shown in Table 4 below.

Table 4. The temporal occurrence of (a) adult and (b) juvenile California Central Valley steelhead at locations in the Central Valley. Darker shades indicate months of greatest relative abundance.

(a) Adult migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1]Sacramento R. at Fremont Weir	░	░	░	░	░							░	░	░	░	▓	■	■	■	▓	░	░	░	░
[2]Sacramento R. at RBDD	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	░	▓	▓	■	▓	░	░	░	░
[3]Mill & Deer Creeks	▓	▓	■	▓	▓	░	░	░	░	░	░	░							▓	■	■	░	░	░
[4]Mill Creek at Clough Dam	░	░	▓	■	▓	▓	░	░										░	▓	■	■	■	▓	▓
[5]San Joaquin River	■	■	▓	▓	░	░							░	░	░	░	▓	▓	▓	▓	▓	▓	■	■
(b) Juvenile migration																								
Location	Jan		Feb		Mar		Apr		May		Jun		Jul		Aug		Sep		Oct		Nov		Dec	
[1,2]Sacramento R. near Fremont Weir	░	░	░	░	▓	▓	▓	▓	▓	▓	▓	▓	░	░	░	░	░	░	▓	▓	▓	▓	░	░
[6]Sacramento R. at Knights Landing	■	■	■	■	▓	▓	▓	▓	░	░	░	░									░	░	░	░
[7]Mill & Deer Creeks (silvery parr/smolts)	░	░	░	░	▓	■	■	■	■	■	░	░							░	░	░	░	░	░
[7]Mill & Deer Creeks (fry/parr)	░	░	░	░	░	░	▒	▒	■	■	■	■							▒	▒	▒	▒	▒	▒
[8]Chipps Island (clipped)	▓	▓	■	■	▓	▓	░	░	░	░													░	░
[8]ChippsIsland (unclipped)	▓	▓	▓	▓	■	■	■	■	■	■	▒	▒	░	░									░	░
[9]San Joaquin R. at Mossdale			░	░	▓	▓	■	■	■	■	░	░							░	░				
[10]Mokelumne R. (silvery parr/smolts)	░	░	▓	▓	▓	▓	■	■	■	■	▓	▓	▓	▓										
[10]Mokelumne R. (fry/parr)			░	░	░	░	░	░	▓	▓	■	■	▓	▓										
[11]Stanislaus R. at Caswell	░	░	▓	▓	■	■	▓	▓	▓	▓	░	░												
[12]Sacramento R. at Hood	░	░	■	■	■	■	■	■	■	■	■										░	░	░	░

Relative Abundance: ■ = High ▓ = Medium ░ = Low

Sources: [1](Hallock 1957); [2](McEwan 2001); [3](Harvey 1995); [4]CDFW unpublished data; [5]CDFG Steelhead Report Card Data 2007; [6]NMFS analysis of 1998-2011 CDFW data; [7](Johnson & Merrick 2012); [8]NMFS analysis of 1998-2011 USFWS data;

[9]NMFS analysis of 2003-2011 USFWS data; [10]unpublished EBMUD RST data for 2008-2013; [11]Oakdale RST data (collected by FishBio) summarized by John Hannon (Reclamation) ; [12](Schaffter 1980).

2.2.2.1 Critical Habitat: Physical and Biological Features for CCV Steelhead

Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River (up to the confluence with the Merced River), including its tributaries, and the waterways of the Delta. Following is a description of the condition of the inland habitat types used as PBFs for CCV steelhead critical habitat.

Spawning Habitat

Tributaries to the Sacramento and San Joaquin rivers with year-round flows have the primary spawning habitat for CCV steelhead. Most of the available spawning habitat is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

Freshwater Rearing Habitat

Tributaries to the Sacramento and San Joaquin rivers with year-round flows have the primary rearing habitat for CCV steelhead. Intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Freshwater rearing habitat has a high conservation value even if the current conditions are significantly degraded from their natural state.

Freshwater Migration Corridors

Migration corridors contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks, and boulders, side channels, and undercut banks, which augment juvenile and adult mobility, survival, and food supply. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

Estuarine Areas

This PBF is outside of action area for the proposed action. The remaining estuarine habitat for this species is severely degraded by altered hydrologic regimes, poor water quality, reductions in habitat complexity, and competition for food and space with exotic species. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function to provide predator avoidance, as rearing habitat and as an area of transition to the ocean environment.

2.2.2.2 Description of VSP Parameters

Abundance

Historic CCV steelhead run sizes are difficult to estimate given the paucity of data, but may have approached one to two million adults annually (McEwan 2001). By the early 1960s, the steelhead run size had declined to about 40,000 adults (McEwan 2001). Hallock *et al.* (1961) estimated an average of 20,540 adult steelhead through the 1960s in the Sacramento River upstream of the Feather River. Steelhead counts at the RBDD declined from an average of 11,187 for the period from 1967 to 1977, to an average of approximately 2,000 through the early 1990s, with an estimated total annual run size for the entire Sacramento-San Joaquin system, based on RBDD counts, to be no more than 10,000 adults (McEwan & Jackson 1996, McEwan 2001). Steelhead escapement surveys at RBDD ended in 1993 due to changes in dam operations, and comprehensive steelhead population monitoring has not taken place in the Central Valley since then, despite 100 percent marking of hatchery steelhead smolts since 1998. Efforts are underway to improve this deficiency, and a long term adult escapement monitoring plan is being planned (Eilers *et al*. 2010).

Current abundance data is limited to returns to hatcheries and redd surveys conducted on a few rivers. The hatchery data is the most reliable, as redd surveys for steelhead are often made difficult by high flows and turbid water usually present during the winter-spring spawning period.

Coleman National Fish Hatchery (CNFH) operates a weir on Battle Creek, where all upstream fish movement is blocked August through February, during the hatchery spawning season. Counts of steelhead captured at and passed above this weir represent one of the better data sources for the CCV DPS. Steelhead returns to CNFH have fluctuated greatly over the years. From 2003 to 2012, the number of hatchery origin adults has ranged from 624 to 2,968. Since 2003, adults returning to the hatchery have been classified as wild (unclipped) or hatchery produced (adipose clipped). Natural-origin adults counted at the hatchery each year represent a small fraction of overall returns, but their numbers have remained relatively steady, typically 200-500 fish each year, although numbers the past five years have been lower, ranging from 185 to 334 (NMFS 2016b).

Redd counts are conducted in the American River, with an average of 142 redds counted on the American River from 2002-2015 (data from Hannon & Deason 2008, Hannon *et al.* 2003, Chase 2010), with only 58 counted in 2015, a new low for this survey (NMFS 2016b).

The East Bay Municipal Utilities District has included steelhead in their redd surveys on the Lower Mokelumne River since the 1999-2000 spawning season, and the overall trend is a slight increase (2000 to 2010). However, it is generally believed that most of the *O. mykiss* spawning in the Mokelumne River are resident fish (Satterthwaite *et al.* 2010), which are not part of the CCV steelhead DPS.

The returns of steelhead to the Feather River Hatchery have decreased greatly over time, with only 679, 312, and 86 fish returning in 2008, 2009, and 2010, respectively. This is despite the fact that almost all of these fish are hatchery fish, and stocking levels have remained fairly constant, suggesting that smolt and/or ocean survival was poor for these smolt classes. The average return in 2006-2010 was 649, while the average from 2001 to 2005 was 1,963. Data that is more recent shows a slight increase in the annual returns, which averaged 1,134 fish from 2011 to 2015 (CDFW 2016).

The Clear Creek steelhead population appears to have increased in abundance since Saeltzer Dam was removed in 2000, as the number of redds observed in surveys conducted by the USFWS has steadily increased since 2001. The average redd index from 2001 to 2011 is 157, representing somewhere between 128 and 255 spawning adult steelhead on average each year. From 2011 through 2015, an average of 231 redds has been observed in Clear Creek. The vast majority of these steelhead are natural-origin fish, as no hatchery steelhead are stocked in Clear Creek, and adipose fin clipped steelhead are rarely observed in Clear Creek (NMFS 2016b).

Catches of steelhead at the fish collection facilities in the southern Delta are another source of information on the relative abundance of the CCV steelhead DPS, as well as the proportion of wild steelhead relative to hatchery steelhead. The overall catch of steelhead at these facilities has been highly variable since 1993. The percentage of unclipped steelhead in salvage has also fluctuated, but has generally declined since 100 percent clipping started in 1998. The number of stocked hatchery steelhead has remained relatively constant overall since 1998, even though the number stocked in any individual hatchery has fluctuated.

Overall, steelhead returns to hatcheries have fluctuated so much from 2001 to 2016 that no clear trend is present, other than the fact that the numbers are still far below those seen in the 1960's and 1970's, and only a tiny fraction of the historical estimate. Returns of natural origin fish are very poorly monitored, but the little data available suggest that the numbers are very small, though perhaps not as variable from year to year as the hatchery returns.

2.2.3.2.2 *Productivity*

An estimated 100,000 to 300,000 naturally produced juvenile steelhead are estimated to leave the Central Valley annually, based on rough calculations from sporadic catches in trawl gear (Good *et al.* 2005). The Mossdale trawls on the San Joaquin River conducted annually by CDFW and USFWS capture steelhead smolts, although usually in very small numbers. These steelhead recoveries, which represent migrants from the Stanislaus, Tuolumne, and Merced rivers, suggest that the productivity of CCV steelhead in these tributaries is very low. In addition, the Chipps Island midwater trawl dataset from the USFWS provides information on the trend (Williams *et al.* 2011). Nobriga and Cadrett (2001) used the ratio of adipose fin-clipped (hatchery) to unclipped (wild) steelhead smolt catch ratios in the Chipps Island trawl from 1998 through 2000 to estimate that about 400,000 to 700,000 steelhead smolts are produced naturally each year in the Central Valley.

Analysis of data from the Chipps Island midwater trawl conducted by the USFWS indicates that natural steelhead production has continued to decline, and that hatchery origin fish represent an increasing fraction of the juvenile production in the Central Valley. Beginning in 1998, all hatchery produced steelhead in the Central Valley have been adipose fin clipped (ad-clipped). Since that time, the trawl data indicates that the proportion of ad-clipped steelhead juveniles captured in the Chipps Island monitoring trawls has increased relative to wild juveniles, indicating a decline in natural production of juvenile steelhead. The proportion of hatchery fish exceeded 90 percent in 2007, 2010, and 2011. Because hatchery releases have been fairly consistent through the years, this data suggests that the natural production of steelhead has been declining in the Central Valley.

Salvage of juvenile steelhead at the CVP and SWP fish collection facilities also indicates a reduction in the natural production of steelhead. The percentage of unclipped juvenile steelhead collected at these facilities declined from 55 percent to 22 percent over the years 1998 to 2010 (NMFS 2011b).

In contrast to the data from Chipps Island and the CVP and SWP fish collection facilities, some populations of wild CCV steelhead appear to be improving (Clear Creek) while others (Battle Creek) appear to be better able to tolerate the recent poor ocean conditions and dry hydrology in the Central Valley compared to hatchery produced fish (NMFS 2011b). Since 2003, fish returning to the CNFH have been identified as wild (adipose fin intact) or hatchery produced (ad-clipped). Returns of wild fish to the hatchery have remained fairly steady at 200-300 fish per year, but represent a small fraction of the overall hatchery returns. Numbers of hatchery origin fish returning to the hatchery have fluctuated much more widely, ranging from 624 to 2,968 fish per year. The Mokelumne River steelhead population is supplemented by Mokelumne River Hatchery production.

2.2.3.2.3 *Spatial Structure*

About 80 percent of the historical spawning and rearing habitat once used by anadromous *O. mykiss* in the Central Valley is now upstream of impassible dams (Lindley *et al.* 2006). The extent of habitat loss for steelhead most likely was much higher than that for salmon because steelhead were undoubtedly more extensively distributed.

Steelhead are well distributed throughout the Central Valley below the major rim dams (Good *et al.* 2005; NMFS 2011b). Zimmerman *et al.* (2009) used otolith microchemistry to show that *O. mykiss* of anadromous parentage occur in all three major San Joaquin River tributaries, but at low levels, and that these tributaries have a higher percentage of resident *O. mykiss* compared to the Sacramento River and its tributaries.

The low adult returns to the San Joaquin tributaries and the low numbers of juvenile emigrants typically captured suggest that existing populations of CCV steelhead on the Tuolumne, Merced, and lower San Joaquin rivers are severely depressed. The loss of these populations would severely impact CCV steelhead spatial structure and further challenge the viability of the CCV steelhead DPS.

The NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014), includes recovery criteria for the spatial structure of the DPS which provide one viable population in the Northwestern California diversity group, two viable populations in the basalt and porous lava diversity group, four viable populations in the northern Sierra Nevada diversity group, and two viable populations in the southern Sierra Nevada diversity group, in addition to maintaining dependent populations, are needed for recovery.

Efforts to provide passage of salmonids over impassable dams have the potential to increase the spatial diversity of Central Valley steelhead populations if the passage programs are implemented for steelhead. In addition, the SJRRP calls for a combination of channel and structural modifications along the San Joaquin River below Friant Dam, releases of water from Friant Dam to the confluence of the Merced River, and the reintroduction of spring-run and fall-run Chinook salmon. If the SJRRP is successful, habitat improved for CV spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011b).

2.2.3.2.4 *Diversity*

a. Genetic Diversity: CCV steelhead abundance and growth rates continue to decline, largely the result of a significant reduction in the amount and diversity of habitats available to these populations (Lindley *et al.* 2006). Recent reductions in population size are also supported by genetic analysis (Nielsen *et al.* 2003). Garza and Pearse (2008) analyzed the genetic relationships among CCV steelhead populations and found that, unlike the situation in coastal California watersheds, fish below barriers in the Central Valley were often more closely related to below barrier fish from other watersheds than to *O. mykiss* above barriers in the same watershed. This pattern suggests the ancestral genetic structure is still relatively intact above barriers, but may have been altered below barriers by stock transfers.

The genetic diversity of CCV steelhead is also compromised by hatchery origin fish, which likely comprise the majority of the annual spawning runs, placing the natural population at a high risk of extinction (Lindley *et al.* 2007). There are four hatcheries (CNFH, Feather River Fish Hatchery, Nimbus Fish Hatchery, and Mokelumne River Fish Hatchery) in the Central Valley, which combined release approximately 1.6 million yearling steelhead smolts each year. These programs are intended to mitigate for the loss of steelhead habitat caused by dam construction, but hatchery origin fish now appear to constitute a major proportion of the total abundance in the DPS. Two of these hatchery stocks (Nimbus and Mokelumne River hatcheries) originated from outside the DPS (primarily from the Eel and Mad rivers) and are not presently considered part of the DPS.

b. Life-History Diversity: Steelhead in the Central Valley historically consisted of both summer-run and winter-run migratory forms, based on their state of sexual maturity at the time of river entry and the duration of their time in freshwater before spawning.

Only winter-run (ocean maturing) steelhead currently are found in California Central Valley rivers and streams (Moyle 2002; McEwan & Jackson 1996). Summer-run steelhead have been extirpated due to a lack of suitable holding and staging habitat, such as cold-water pools in the headwaters of CV streams, presently located above impassible dams (Lindley *et al.* 2006).

Juvenile steelhead (parr) rear in freshwater for one to three years before migrating to the ocean as smolts (Moyle 2002). Hallock *et al.* (1961) aged 100 adult steelhead caught in the Sacramento

River upstream of the Feather River confluence in 1954, and found that 70 had smolted at age-2, 29 at age-1, and one at age-3. Seventeen of the adults were repeat spawners, with three fish on their third spawning migration, and one on its fifth. Age at first maturity varies among populations. In the Central Valley, most steelhead return to their natal streams as adults at a total age of two to four years (Hallock *et al.* 1961, McEwan & Jackson 1996). In contrast to the upper Sacramento River tributaries, Lower American River juvenile steelhead have been shown to smolt at a very large size (270 to 350 mm FL), and nearly all smolt at age-1 (Sogard *et al.* 2012).

2.2.3.2.5 *Summary of DPS Viability*

All indications are that natural CCV steelhead have continued to decrease in abundance and in the proportion of natural fish over the past 25 years (Good *et al.* 2005; NMFS 2011b); the long-term trend remains negative. Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally-produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin-clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show an overall very low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for Central Valley salmonids. Using data through 2005, Lindley *et al.* (2007) found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the Central Valley provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, as described in the recent 5-year Status Review (NMFS 2016b), most wild CCV populations 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 wild 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.

Summary of CCV Steelhead DPS Viability

All indications are that natural CCV steelhead have continued to decrease in abundance over the past 25 years (Good *et al.* 2005; NMFS 2011b). Hatchery production and returns are dominant over natural fish. Continued decline in the ratio between naturally produced juvenile steelhead to hatchery juvenile steelhead in fish monitoring efforts indicates that the wild population abundance is declining. Hatchery releases (100 percent adipose fin clipped fish since 1998) have remained relatively constant over the past decade, yet the proportion of adipose fin-clipped hatchery smolts to unclipped naturally produced smolts has steadily increased over the past several years.

Although there have been recent restoration efforts in the San Joaquin River tributaries, CCV steelhead populations in the San Joaquin Basin continue to show a decline, an overall low abundance, and fluctuating return rates. Lindley *et al.* (2007) developed viability criteria for CV salmonids using data through 2005, found that data were insufficient to determine the status of any of the naturally-spawning populations of CCV steelhead, except for those spawning in rivers adjacent to hatcheries, which were likely to be at high risk of extinction due to extensive spawning of hatchery-origin fish in natural areas.

The widespread distribution of wild steelhead in the CV provides the spatial distribution necessary for the DPS to survive and avoid localized catastrophes. However, these populations are frequently very small, and lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change (NMFS 2011b). The most recent status review of the CCV steelhead DPS (NMFS 2011b) found that the status of the population appears to have worsened since the 2005 status review (Good *et al.* 2005), when it was considered to be in danger of extinction.

Critical Habitat: Physical and Biological Features for CCV Steelhead

Critical habitat was designated for CCV steelhead on September 2, 2005 (70 FR 52488). Critical habitat for CCV steelhead includes stream reaches such as those of the Sacramento, Feather, and Yuba Rivers, and Deer, Mill, Battle, and Antelope creeks in the Sacramento River basin; the San Joaquin River, including its tributaries, and the waterways of the Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the OHWM. In areas where the OHWM has not been defined, the lateral extent will be defined by the bankfull elevation (defined as the level at which water begins to leave the channel and move into the floodplain; it is reached at a discharge that generally has a recurrence interval of 1 to 2 years on the annual flood series) (Bain & Stevenson 1999; 70 FR 52488). Critical habitat for CCV steelhead is defined as specific areas that contain the PBFs and physical habitat elements essential to the conservation of the species. Following are the inland habitat types used as PBFs for CCV steelhead. PBFs for CCV steelhead include:

1. <u>Freshwater Spawning Habitat</u>

Freshwater spawning sites are those with water quantity and quality conditions and substrate supporting spawning, incubation, and larval development. Most of the available spawning habitat for steelhead in the CV is located in areas directly downstream of dams due to inaccessibility to historical spawning areas upstream and the fact that dams are typically built at high gradient locations. These reaches are often impacted by the upstream impoundments, particularly over the summer months, when high temperatures can have adverse effects upon salmonids spawning and rearing downstream of the dams. Even in degraded reaches, spawning habitat has a high conservation value as its function directly affects the spawning success and reproductive potential of listed salmonids.

2. <u>Freshwater Rearing Habitat</u>

Freshwater rearing sites are those with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and survival; water quality and forage supporting juvenile development; and natural cover such as shade, submerged and overhanging LWM, log jams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks. Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. Some complex, productive habitats with floodplains remain in the system (*e.g.*, the lower Cosumnes River, Sacramento River reaches with setback levees [*i.e.*, primarily located upstream of the City of Colusa]) and flood bypasses (*i.e.*, Yolo and Sutter bypasses). However, the channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento-San Joaquin system typically have low habitat complexity, low abundance of food organisms, and offer little protection from either fish or avian predators. Freshwater rearing habitat also has a high conservation value even if the current conditions are significantly degraded from their natural state. Juvenile life stages of salmonids are dependent on the function of this habitat for successful survival and recruitment.

3. Freshwater Migration Corridors

Ideal freshwater migration corridors are free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. They contain natural cover such as riparian canopy structure, submerged and overhanging large woody objects, aquatic vegetation, large rocks and boulders, side channels, and undercut banks, which augment juvenile and adult mobility, survival, and food supply. Migratory corridors are downstream of the spawning areas and include the lower mainstems of the Sacramento and San Joaquin rivers and the Delta. These corridors allow the upstream and downstream passage of adults, and the emigration of smolts. Migratory habitat condition is strongly affected by the presence of barriers, which can include dams (*i.e.*, hydropower, flood control, and irrigation flashboard dams), unscreened or poorly screened diversions, degraded water quality, or behavioral impediments to migration. For successful survival and recruitment of salmonids, freshwater migration corridors must function sufficiently to provide adequate passage. For this reason, freshwater migration corridors are considered to have a high conservation value even if the migration corridors are significantly degraded compared to their natural state.

4. Estuarine Areas

Estuarine areas free of migratory obstructions with water quality, water quantity, and salinity conditions supporting juvenile and adult physiological transitions between fresh and salt water are included as a PBF. Natural cover such as submerged and overhanging LWM, aquatic vegetation, and side channels, are suitable for juvenile and adult foraging. Estuarine areas are considered to have a high conservation value as they provide factors which function to provide predator avoidance and as a transitional zone to the ocean environment.

2.2.3 Southern DPS of North American Green Sturgeon

The following section entails the status of the species for the southern distinct population segment (sDPS) of North American green sturgeon. This section establishes the life history and viability for sDPS green sturgeon, and discusses their critical habitat. The critical habitat analysis is approached by examining the PBFs of that critical habitat, and this analysis considers separately freshwater and estuarine environments. Throughout this analysis of life history, viability, and critical habitat, the focus is upon the CV of California. Therefore, not all aspects of sDPS green sturgeon are presented; for example, the PBFs for the critical habitat in the marine environment are not included.

Summary of sDPS Green Sturgeon Viability

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. The risk of extinction is believed to be moderate because, 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 2010b). Viability is defined as an independent population having a negligible risk of extinction due to threats from demographic variation, local environmental variation, and genetic diversity changes over a 100-year timeframe (McElhany *et al.* 2000). The best available scientific information does not indicate that the extinction risk facing sDPS green sturgeon is negligible over a long-term (~100 year) time horizon; therefore, the sDPS is not believed to be viable. To support this statement, the PVA that was done for sDPS green sturgeon in relation to stranding events (Thomas *et al.* 2013b) may provide some insight. While this PVA model made many assumptions that need to be verified as new information becomes available, it was alarming to note that over a 50-year time period the DPS declined under all scenarios where stranding events were recurrent over the lifespan of a green sturgeon.

Although the population structure of sDPS green sturgeon is still being refined, it is currently believed that only one population of sDPS green sturgeon exists. Lindley *et al.* (2007), in discussing winter-run Chinook salmon, states that an ESU represented by a single population at moderate risk of extinction is at high risk of extinction over the long run. This concern applies to any DPS or ESU represented by a single population, and if this were to be applied to sDPS green sturgeon directly, it could be said that sDPS green sturgeon face a high extinction risk. However, the position of NMFS, upon weighing all available information (and lack of information) has stated the extinction risk to be moderate (NMFS 2010, 2015).

There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their habitat needs.

Southern DPS of North American Green Sturgeon Critical Habitat

Critical habitat was designated for the sDPS green sturgeon on October 9, 2009 (74 FR 52300). A full and exact description of all sDPS green sturgeon critical habitat, including excluded areas, can be found at 50 CFR § 226.219. Critical habitat includes the stream channels and waterways in the Delta to the OHWM. Critical habitat also includes the main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the Fish Barrier Dam adjacent to the FRFH, and the Yuba River upstream to Daguerre Dam. 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. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are also included as critical habitat for sDPS green sturgeon.

Critical habitat for sDPS green sturgeon includes PBFs within the defined area that are essential to the conservation of the species. PBFs for sDPS green sturgeon have been designated for freshwater riverine systems, estuarine habitats, and nearshore coastal areas. In keeping with the focus on the Feather River, we will limit our discussion to freshwater riverine systems. The PBFs within the Action Area for sDPS green sturgeon are: (1) food resources, (2) adequate flow regime for all life stages, (3) water quality, (4) migratory corridors, (5) adequate water depth for all life stages, and (6) adequate sediment quality.

Freshwater Riverine Systems

1. Food Resources

Abundant food items for larval, juvenile, subadult, and adult life stages for sDPS green sturgeon should be present in sufficient amounts to sustain growth, development, and support basic metabolism. Although specific information on food resources for green sturgeon within freshwater riverine systems is lacking, they are presumed to be generalists and opportunists that feed on similar prey as other sturgeons (Israel & Klimley 2008). Seasonally abundant drifting and benthic invertebrates have been shown to be the major food items of shovelnose and pallid sturgeon in the Missouri River (Wanner *et al.* 2007), lake sturgeon in the St. Lawrence River (Nilo *et al.* 2006), and white sturgeon in the lower Columbia River (Muir *et al.* 2000). As sturgeons grow, they begin to feed on oligochaetes, amphipods, smaller fish, and fish eggs as represented in the diets of lake sturgeon (Nilo *et al.* 2006), pallid sturgeon (Gerrity *et al.* 2006), and white sturgeon (Muir *et al.* 2000).

2. Substrate Type or Size

Critical habitat in the freshwater riverine system should include substrate suitable for egg deposition and development, and the development of larval, subadult, and adult life stages. For example, spawning is believed to occur over substrates ranging from clean sand to bedrock, with preferences for cobble (Emmett *et al.* 1991). Eggs are likely to adhere to substrates or settle into crevices between substrates (Van Eenennaam *et al.* 2001; Deng *et al.* 2002). Larvae exhibited a preference for benthic structure during laboratory studies (Van Eenennaam *et al.* 2001; Deng *et al.* 2002; Kynard *et al.* 2005), and may seek refuge within crevices, but use flat-surfaced substrates for foraging (Nguyen & Crocker 2006).

3. Water Flow

An adequate flow regime is necessary for normal behavior, growth, and survival of all life stages in the upper Sacramento River. Such a flow regime should include stable and sufficient water flow rates in spawning and rearing reaches to maintain water temperatures within the optimal range for egg, larval, and juvenile survival and development (11 – 19°C) (Mayfield & Cech 2004; Van Eenennaam *et al.* 2005; Allen *et al.* 2006). Sufficient flow is also needed to reduce the incidence of fungal infestations of the eggs, and to flush silt and debris from cobble, gravel, and other substrate surfaces to prevent crevices from being filled in and to maintain surfaces for feeding. Successful migration of adult green sturgeon to and from spawning grounds is also dependent on sufficient water flow. Spawning in the Sacramento River is believed to be triggered by increases in water flow to about 14,000 cfs (Brown 2007). The average daily water flow during spawning months ranges from 6,900 – 10,800 cfs (Brown 2007). In Oregon's Rogue River, the northern DPS (nDPS) green sturgeon have been shown to emigrate to sea during the autumn and winter when water temperatures dropped below 10°C and flows increased (Erickson *et al.* 2002). On the Klamath River, the fall outmigration of nDPS green sturgeon has been shown to coincide with a significant increase in discharge resulting from the onset of the rainy season (Benson *et al.* 2006). On the Sacramento River, flow regimes are largely dependent on releases from Shasta Dam, thus the operation of this dam could have profound effects upon sDPS green sturgeon habitat.

4. Water Quality

Adequate water quality, including temperature, salinity, oxygen content, and other chemical characteristics are necessary for normal behavior, growth, and viability of all life stages. Suitable water temperatures would include: stable water temperatures within spawning reaches; temperatures within 11 – 17°C (optimal range is 14 – 16°C) in spawning reaches for egg incubation (March – August) (Van Eenennaam *et al.* 2005); temperatures below 20°C for larval development (Werner *et al.* 2007); and temperatures below 24°C for juveniles (Mayfield & Cech 2004; Allen *et al.* 2006). Suitable salinity levels range from fresh water (< 3 ppt) for larvae and early juveniles to brackish water (10 ppt) for juveniles prior to their transition to salt water. Prolonged exposure to higher salinities may result in decreased growth and activity levels and even mortality (Allen & Cech 2007). Adequate levels of dissolved oxygen (DO) are needed to support oxygen consumption by early life stages, ranging from 61.78 to 76.06 mg O_2 hr^{-1} kg^{-1} for juveniles (Allen & Cech 2007).

Suitable water quality would also include water with acceptably low levels of contaminants (*e.g.*, pesticides, organochlorines, selenium, elevated levels of heavy metals, *etc.*) that may disrupt normal development of embryonic, larval, and juvenile stages of green sturgeon. Poor water quality can have adverse effects on growth, reproductive development, and reproductive success. Studies on the effects of water contaminants upon green sturgeon are needed; studies performed upon white sturgeon have clearly demonstrated the negative impacts contaminants can have upon white sturgeon biology (Foster *et al.* 2001a; 2001b; Feist *et al.* 2005; Fairey *et al.* 1997; Kruse & Scarnecchia 2002). Legacy contaminants, such as mercury, still persist in the watershed and pulses of pesticides have been identified in winter storm discharges throughout the Sacramento River basin, CV, and the Delta.

5. Migratory Corridor

Safe and unobstructed migratory pathways are necessary for adult green sturgeon to migrate to and from spawning habitats, and for larval and juvenile green sturgeon to migrate downstream from spawning and rearing habitats within freshwater rivers to rearing habitats within the estuaries. Unobstructed passage throughout the Sacramento River up to Keswick Dam (RM 302) is important, because optimal spawning habitats for green sturgeon are believed to be located upstream of the RBDD (RM 242).

6. Depth

Deep pools of ≥ 5 m depth are critical for adult green sturgeon spawning and for summer holding within the Sacramento River. Summer aggregations of green sturgeon are observed in these pools in the upper Sacramento River upstream of the Glenn-Colusa Irrigation District (GCID). The significance and purpose of these aggregations are unknown at the present time, but may be a behavioral characteristic of green sturgeon. Adult green sturgeon in the Klamath and Rogue rivers also occupy deep holding pools for extended periods of time, presumably for feeding, energy conservation, and/or refuge from high water temperatures (Erickson *et al.* 2002; Benson *et al.* 2006). As described above, approximately 54 pools with adequate depth have been identified in the Sacramento River upstream of the GCID location.

7. Sediment Quality

Sediment should be of the appropriate quality and characteristics necessary for normal behavior, growth, and viability of all life stages. This includes sediments free of contaminants (*i.e.*, elevated levels of heavy metals such as mercury, copper, zinc, cadmium, and chromium, polycyclic aromatic hydrocarbons, and organochlorine pesticides) that can result in negative effects on any life stage of green sturgeon or their prey. Based on studies of white sturgeon, bioaccumulation of contaminants from feeding on benthic species may similarly have a negative affect the growth, reproductive development, and reproductive success of green sturgeon. The Sacramento River and its tributaries have a long history of contaminant exposure from abandoned mines, separation of gold ore from mine tailings using mercury, and agricultural practices with pesticides and fertilizers, which result in deposition of these materials in the sediment horizons in the river channel. The San Joaquin River is a source for many of these same contaminants, although pollution and runoff from agriculture are the predominant driving force. Disturbance of these sediment horizons by natural or anthropogenic actions can liberate sequestered contaminants into the river. This is a continuing concern throughout the watershed.

2.2.4 Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley 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 & Cayan 1995). An altered seasonality results in runoff events occurring earlier in the year due to a shift in precipitation falling as rain rather than snow (Roos 1991; Dettinger *et al.* 2004). Specifically, the Sacramento River basin annual runoff amount for April – July has been decreasing since about 1950 (Roos 1987, 1991). Increased temperatures influence the timing and magnitude patterns of the hydrograph.

The magnitude of snowpack reductions is subject to annual variability in precipitation and air temperature. The large spring snow water equivalent (SWE) percentage changes, late in the snow season, are due to a variety of factors including reduction in winter precipitation and temperature increases that rapidly melt spring snowpack (VanRheenen *et al.* 2004). Factors modeled by VanRheenen *et al.* (2004) show that the melt season shifts to earlier in the year, leading to a large percent reduction of spring SWE (up to 100% in shallow snowpack areas). Additionally, an air temperature increase of 2.1°C (3.8°F) is expected to result in a loss of about half of the average April snowpack storage (VanRheenen *et al.* 2004). The decrease in spring SWE (as a percentage) would be greatest in the region of the Sacramento River watershed, at the north end of the CV, where snowpack is shallower than in the San Joaquin River watersheds to the south.

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). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951 – 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the CV are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally-producing fall-run Chinook salmon are thermally acceptable. This would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2011). 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. Even in tributaries with cool water springs, in years of extended drought and warming water temperatures, unsuitable conditions may occur. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating, and would be susceptible to warming water temperatures. In Butte Creek, fish are limited to low elevation habitat that is currently thermally marginal, as demonstrated by high summer mortality of adults in 2002 and 2003, and will become intolerable within decades if the climate warms as expected. Ceasing water diversion for power production from the summer holding reach in Butte Creek resulted in cooler water temperatures, more adults surviving to spawn, and extended population survival time (Mosser *et al.* 2013).

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, however, the effects may be even greater in some cases, as juvenile 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 steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough *et al.* 2001). In fact, McCullough *et al.* (2001) recommended an optimal incubation temperature at or below 11°C to 13°C (52°F to 55°F). Successful smoltification in steelhead may be impaired by temperatures above 12°C (54°F), as reported in Richter and Kolmes (2005). As stream temperatures warm due to climate change, the growth rates of juvenile steelhead could increase in some systems that are currently relatively cold, but potentially at the expense of decreased survival due to higher metabolic demands and greater presence and activity of predators. Stream temperatures that are currently marginal for spawning and rearing may become too warm to support wild steelhead populations.

Southern DPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. Anderson-Cottonwood Irrigation Dam (ACID) is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperature is higher than ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the CV (*e.g.,* the Feather River) is limited, in part, by late spring and summer water temperatures. Similar to salmonids in the CV, green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely to be further limited if water temperatures increase and suitable spawning habitat remains inaccessible.

In summary, observed and predicted climate change effects are generally detrimental to the 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 there is uncertainty associated with projections, which increases over time, the direction of change is relatively certain (McClure *et al.* 2013).

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 is not the same as the project boundary area because the action area must delineate all areas where federally listed fishes and their habitats may be affected by the implementation of the proposed action. The action area consists of the D-Unit in the OWA and the mainstem Feather River and levees adjacent to the D-Unit **(**Figure 2).

The proposed action is located on the east bank of the Feather River, directly adjacent to the Thermalito Afterbay Outlet, 8 miles southwest of the town of Oroville, CA. For the purposes of addressing potential direct and indirect effects of the proposed action on listed fish species and their designated critical habitat, the action area includes the entire D-Unit of the OWA as well as the riverbed and banks of the Feather River within the footprint of the proposed hydraulic improvements (up to the ordinary high water mark [OHWM]). Additionally, the action area encompasses the waters of the Feather River extending across the width of the river and several hundred feet downstream of the proposed hydraulic improvements that could be affected by temporary increases in turbidity, sedimentation, or noise during in-water construction activities.

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).

The Feather River

The Feather River today is very much changed from its historical condition. The opinion for the Oroville Facilities (NMFS 2016) provide details about environmental baseline in the Feather River. These changes began in earnest with the California Gold Rush, and continued with the development of man-made dams and other structures to control the flow, storage, and transport of water, and the development of hydroelectric power. The largest dam on the Feather River, and in fact the United States, is Oroville Dam. It is such a focal point of river alteration that the Feather River can effectively be divided into two parts: the Upper Feather River, including all streams, tributaries, and headwaters of the Feather River, and the Lower Feather River from Oroville Dam to the confluence with the Sacramento River at Verona (Figure 3). The Lower Feather River watershed encompasses about 803 square miles. There are approximately 190 miles of major creeks and rivers, 695 miles of minor streams, and 1,266 miles of agricultural water delivery canals. The river flows approximately 60 miles north to south before entering the Sacramento River at Verona. The river is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley. Oroville Dam is a major component of the SWP, and it provides virtually all the water delivered by the California SWP. Flows are regulated for water supply and flood control through releases at Oroville Dam, and to a lesser extent, flows are regulated to maximize production of hydroelectric power.

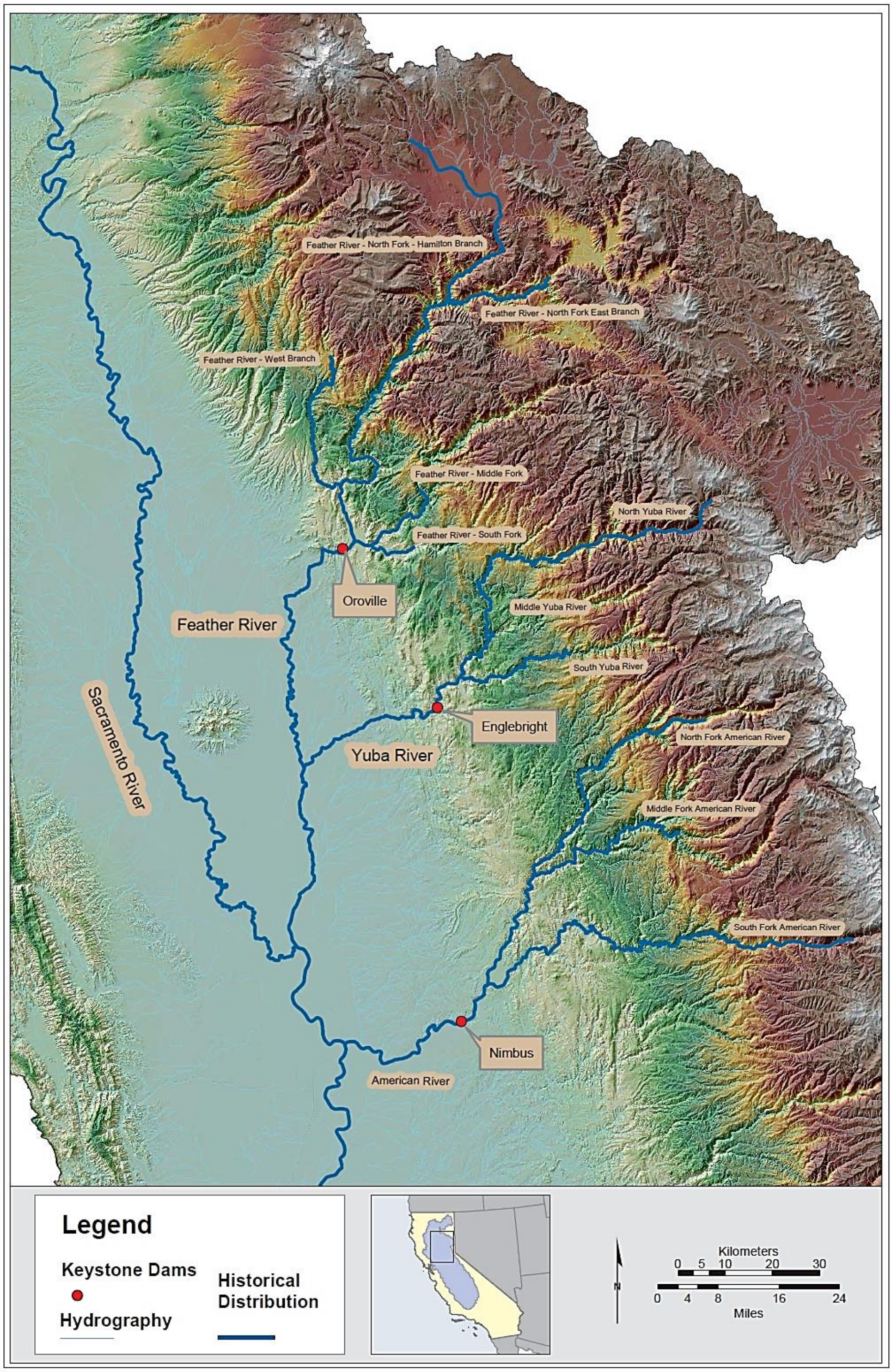

Figure 3. Map of the Feather River watershed.

High flows in the winter of 2016-17, have impacted survival of ESA listed salmonids, and adversely impacted the designated critical habitat in the Feather River. The high have resulted in juvenile salmonids being stranded, eggs being scoured out of the gravel, and juvenile fishes prematurely being moved downstream. The high flows have resulted in large changes in the river, with erosion of the riverbanks and high loads of sediment being deposited. The adverse effects of the high flows in the winter of 2016-17, coupled with the drought conditions from 2012 through 2016, have likely impacted the recovery of ESA listed salmonids. It is likely that the numbers of ESA listed salmonids has declined, and the critical habitat has degraded in the Feather River since the most recent status reviews for CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon. At this time, it unclear if there were adverse impacts to the sDPS of North American green sturgeon due to the high flows.

Oroville Wildlife Area D-Unit

OWA is owned by the State of California and managed CDFW. It lies within FERC's project 2100 boundary, which is administered by DWR. The action area consists of the OWA D-Unit, which is a highly disturbed floodplain that includes extensive, isolated ridges and piles of rock left by gold dredging and drainage canals that were excavated during use of the site as a borrow area for construction of the Oroville Dam. The ground surface elevation is approximately 115 feet in the northern part of the project area and approximately 100 feet in the southern project area. The action area is a basin that is entirely disconnected from the Feather River during times of low flow. A berm along the perimeter of the action area adjacent to the river is generally between 15 and 20 feet higher in elevation than the adjacent land. During times of high flow, water flows into and out of the action area via a system of inflow and outflow weirs. The interior of the action area contains a network of channels and disconnected ponds. The bottoms of these interior channels and ponds are, in many places, lower in elevation than the adjacent Feather River.

2.4.1 Status of Species and Critical Habitat in the Action Area

The action area is within designated critical habitat for CV spring-run Chinook salmon and CCV steelhead. The action area is located on the west bank of the Feather River between the Thermalito Afterbay and SR 70, encompassing the Feather River and associated floodplains and riparian areas within and adjacent to OWA. It functions primarily as a migratory corridor and rearing habitat for CV spring-run Chinook salmon and CCV steelhead, and the Southern DPS of North American green sturgeon. It is adjacent to known CV spring-run Chinook salmon spawning areas along the upper reaches and secondary channels of the LFC and green sturgeon spawning areas below the Thermalito Afterbay Outlet and the deep scour hole below the Fish Barrier Dam. Due to the life history timing of spring-run Chinook salmon, steelhead, and North American green sturgeon, it is possible for one or more of the following life stages to be present within the action area throughout the year: adult migrants or rearing and emigrating juveniles.

Before the construction of Oroville Dam, the Feather River was impacted by gold mining. The effects of the dredging are still very visible just downstream of the city of Oroville, along the LFC. The effects of hydraulic mining over 100 hundred years ago still results in increased amounts of sediment in the rivers today, and modifications in stream channels also persist.

While the extent of upstream passage had been altered by earlier dams, the construction of Oroville Dam changed the amount and extent of available habitat for upstream migrating salmonids (Figure 4). Before Oroville Dam, some separation of spawning CV spring-run Chinook salmon and fall-run Chinook salmon still existed. It is likely that there was some overlap of spring-run Chinook salmon and fall-run Chinook salmon spawning at the time of construction of Oroville Dam. With the advent of Oroville Dam (without fish passage) both of these populations were spawning in the same geographical area and with overlapping spawning timing.

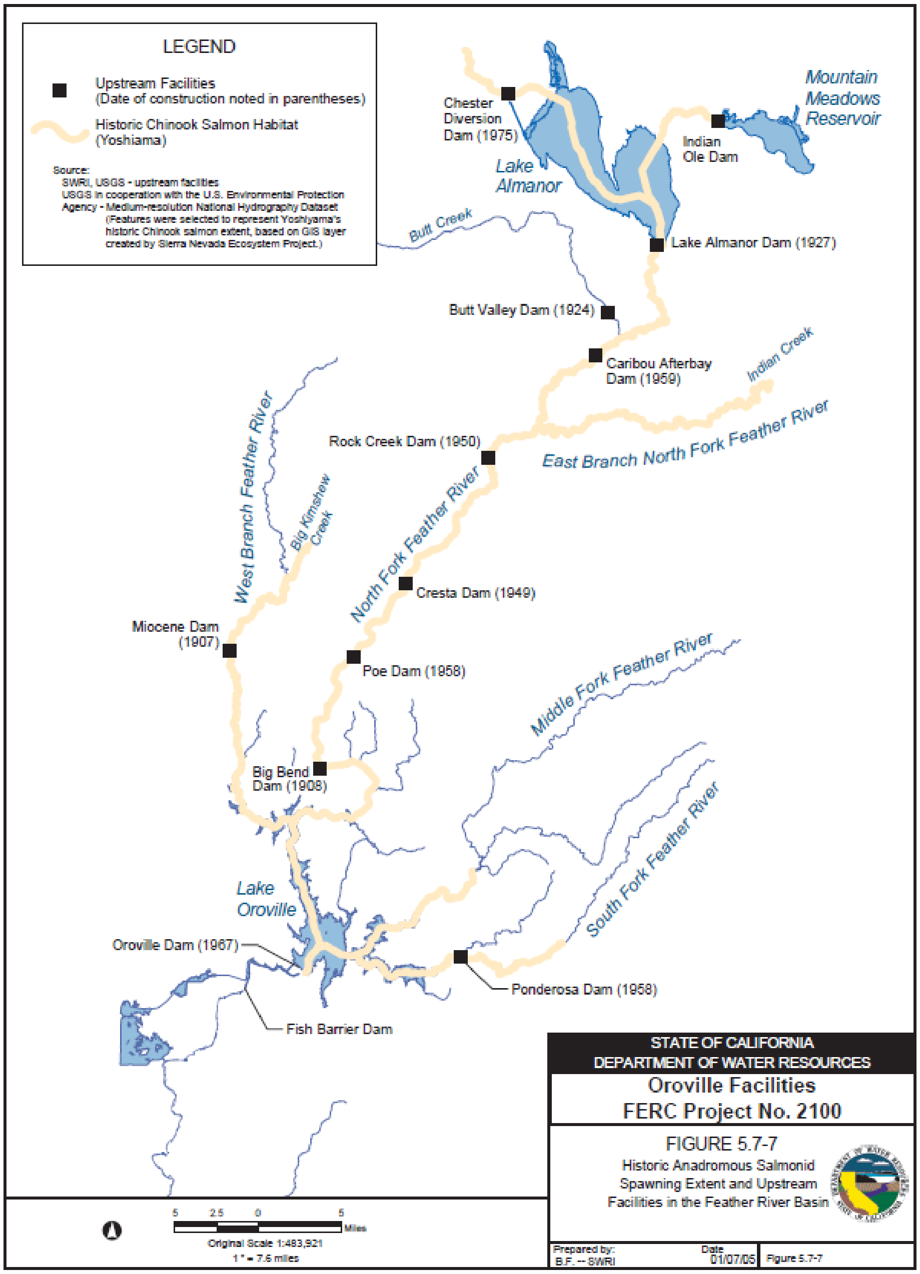

Figure 5. Historic Range of Salmonid Habitat Upstream of Oroville Dam.

Before construction of Oroville Dam, CV spring-run Chinook salmon utilized the upper tributaries of the Feather River for spawning. CV spring-run Chinook salmon would ascend the Feather River in the spring and summer as sexually immature fish, and develop to maturity by fall and then spawn. Although some overlap of CV spring-run and fall-run Chinook salmon spawning areas was already occurring before the dam was built, competition for use of the existing downstream spawning areas increased with the construction of Oroville Dam and ancillary facilities. With the construction of Oroville Dam, fish passage is halted on the Feather River at the Fish Barrier Dam just downstream of Oroville Dam. For the CV spring-run Chinook salmon that now return to the river, the options are to either spawn naturally in the river, utilizing the remaining habitat in the lower reaches of the Feather River below the Fish Barrier Dam at RM 67, or to ascend the fish ladder which begins at the Fish Barrier Dam and enters the FRFH where the fish are then artificially propagated. The amount of habitat available within the Feather River is reduced by Oroville Dam, and CV spring-run Chinook salmon are now forced to spawn in the same areas used by fall-run Chinook salmon. This leads to a number of problems, such as redd superimposition, hybridization, competition for resources, etc. Furthermore, Oroville Dam has changed the river's natural hydrology, altered the natural flow regime, and blocked the transport of sediment and the recruitment of large woody material.

2.4.1.1 Central Valley Spring-run Chinook Salmon

The CV spring-run Chinook salmon ESU includes all naturally spawned populations in the Feather River as well as fish from the FRFH CV spring-run Chinook salmon program. NMFS' Central Valley Technical Recovery Team believes that the existing CV spring-run Chinook salmon population in the Feather River, including the hatchery fish, may be the only remaining representatives of this important ESU component and that the Feather River hatchery CV spring-run Chinook salmon stock may play an important role in the recovery of CV spring-run Chinook salmon in the Feather River Basin (FERC 2007).

Adult CV spring-run Chinook salmon enter the Feather River as immature adults from March to June (Painter *et al.* 1977, Reynolds *et al.* 1993, CDFG 1998, Yoshiyama *et al.* 1998, Sommer *et al.* 2001) and spawn in the autumn during September and October (Sommer *et al.* 2001). Spawning occurs in gravel beds that are often located at the tails of holding pools (USFWS 1995a) and most CV spring-run Chinook salmon spawn in the upper reaches of the LFC (DWR 2007; Bilski 2008; Clark *et al.* 2008; Chappell 2009). Suitable water temperatures for spawning are 42 – 58°F (~5.6 - 14.4ºC). Incubation may extend through March with suitable incubation temperatures between 48 – 58°F (~8.8 - 14.4ºC) (DWR 2007). Studies have confirmed that juvenile rearing and probably some adult spawning are associated with secondary channels within the Feather River LFC. The lower velocities, smaller substrate size, and greater amount of cover (compared to the main river channel) likely make these side-channels more suitable for juvenile CV spring-run Chinook salmon rearing. Currently, this type of habitat comprises less than one percent of the available habitat in the LFC (DWR 2007).

Solid data on naturally spawning CV spring-run Chinook salmon in the Feather River does not exist. There is some natural production of CV spring-run Chinook salmon in the river, and these natural spawners are of greatest interest for conservation. DWR and CDFW have good data on CV spring-run Chinook salmon that return to the FRFH in the fall; however, data on natural spawners is less clear. The escapement survey monitors for Hallprint$^{©}$-tagged CV spring-run Chinook salmon and collects length, spawn condition, and other biological data, but the survey cannot estimate the number of spawners because of the overlap in spawning with fall-run. Data does indicate, however, that CV spring-run Chinook salmon do spawn successfully in the river.

There are multiple issues with both the FRFH and the naturally spawning fish in the river. The primary problem is the overlap in time and space with fall-run Chinook salmon leading to hybridization between the two runs in the river. Poor hatchery practices that historically led to mixing and interbreeding of the two runs within the hatchery also serves to exacerbate the situation. Although hatchery practices have improved and strong efforts are made to differentiate and breed separately CV spring-run Chinook salmon from fall-run Chinook salmon in the Feather River, they have nevertheless been compromised such that their genetics are something of a mix between fall-run and CV spring-run Chinook salmon. While hatchery practices may be able to alleviate some of the problems of genetic mixing of the two runs, those fish that spawn in the river are still able to mix and interbreed. For this reason, a separation weir has been proposed to physically separate CV spring-run and fall-run Chinook salmon in the river.

Juvenile Chinook salmon in the Feather River have been reported to emigrate as young of year (Seesholtz *et al.* 2004) and most appear to migrate out of the Feather River within days of emergence (DWR 2002, 2007; FERC 2007; Bilski & Kindopp 2009). Juvenile emigration from the Feather River is generally from mid-November through June, with the bulk of emigration occurring during November and December (Painter *et al.* 1977; DWR 2004a; Yuba County Water Agency (YWCA) *et al.* 2007; Bilski & Kindopp 2009). Seesholtz *et al.* (2003) speculate that because juvenile rearing habitat in the LFC of the Feather River is limited, juveniles may be forced to emigrate from the area early due to competition for resources. Rotary screw trap data for 1998 to 2000 documented emigration of CV spring-run Chinook salmon from the Feather River peaking in December, followed by another pulse of juvenile young-of-year emigrants at Live Oak in April and May (DWR 2002; Seesholtz *et al.* 2004). Peak movement of juvenile CV spring-run Chinook salmon in the Sacramento River at Knights Landing occurs in December and again in March and April. However, juveniles also are observed between November and the end of May (Snider & Titus 2000).

A number of past human activities impacted CV spring-run Chinook salmon. Dams have eliminated access to historic holding, spawning, and rearing habitat and have resulted in CV spring-run Chinook salmon and fall-run Chinook salmon spawning and rearing in the same areas, at the same times. This has resulted in increased competition, superimposition of redds, and interbreeding of the two populations. Other anthropogenic activities that have impacted CV spring-run Chinook salmon include modification of the hydrograph, loss of sediment and large wood transport, restriction of lateral movement of the river channel, mining, unscreened water diversions, and riparian vegetation removal.

2.4.1.2 California Central Valley Steelhead

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of CCV steelhead (and their progeny) below natural and manmade barriers in the Sacramento and San Joaquin Rivers and their tributaries, including the Feather River below the Oroville Facilities. FRFH CCV steelhead are also included in this designation. The current Feather River CCV steelhead population appears to be almost entirely supported by the FRFH and is restricted to the river reaches downstream of the Fish Barrier Dam. Because CCV steelhead have similar spawning and rearing preferences as CV spring-run Chinook salmon, the two species are believed to have occupied the same areas with the exception that CCV steelhead are thought to have migrated further upstream in the watershed (DWR 2007). Due to the construction and operation of hydropower projects, including the Oroville facilities (*i.e.*, Oroville Dam and the Fish Barrier Dam), the upper Feather River basin is no longer accessible to CCV steelhead.

CCV steelhead spawn in the Feather River between December and March, with the peak spawning occurring in late January (DWR 2007). Historically, the Feather River below the current site of Oroville Dam was likely used only as a migration corridor to upstream reaches (NMFS 2014). Presently, most of the natural CCV steelhead spawning in the Feather River occurs in the LFC, particularly in its upper reaches near the Hatchery Side Channel, a side-channel located between RM 66 and 67, and between the Table Mountain Bicycle Bridge and Lower Auditorium Riffle. Flows in the Hatchery Side Channel are fed by the discharge from the FRFH. Limited spawning has also been observed below the Thermalito Afterbay Outlet. The smaller substrate size and greater amount of cover in the side channels (compared to the main river channel) also make these areas more suitable for juvenile CCV steelhead rearing. Currently, this type of habitat comprises less than 1 percent of the available habitat in the LFC (DWR 2007). Studies have confirmed that juvenile CCV steelhead rearing, and probably adult spawning, within the Feather River is associated with secondary channels within the LFC (DWR 2005, 2007). Most naturally produced CCV steelhead rear in freshwater for two years before emigration (McEwan & Jackson 1996). Feather River CCV steelhead generally emigrate from about February through September, with peak emigration occurring from March through mid-April. However, empirical and observational data show that juvenile CCV steelhead potentially emigrate during all months of the year from the Feather River. Water temperatures of 54°F or less are considered optimal for smolting and emigrating CCV steelhead.

The number of CCV steelhead entering the FRFH each year generally increased between 1967 and 2003 (Figure 5). CCV steelhead returns to the FRFH have varied substantially over the past several years, with very low returns in some years (2009), and above average returns in others (2013 and 2014). Because almost all returning fish are of hatchery origin and stocking levels have remained fairly constant over the years, the data suggest that adverse freshwater or ocean survival conditions have caused or at least contribute to variability in hatchery returns. The CV experienced three consecutive years of drought (2007-2009) which would likely have impaired survival of naturally produced parr and smolts. However, hatchery origin CCV steelhead are reared and released as one-year olds so drought conditions would likely not have significantly affected this life stage. There may have been a drought effect during freshwater migration. However, poor ocean conditions are known to have occurred in at least 2005 and 2006 (which impacted Chinook populations in the CV) and may well have impacted CCV steelhead populations of both hatchery and natural origin. The current drought (2012-2015) has also likely impacted CCV steelhead populations.

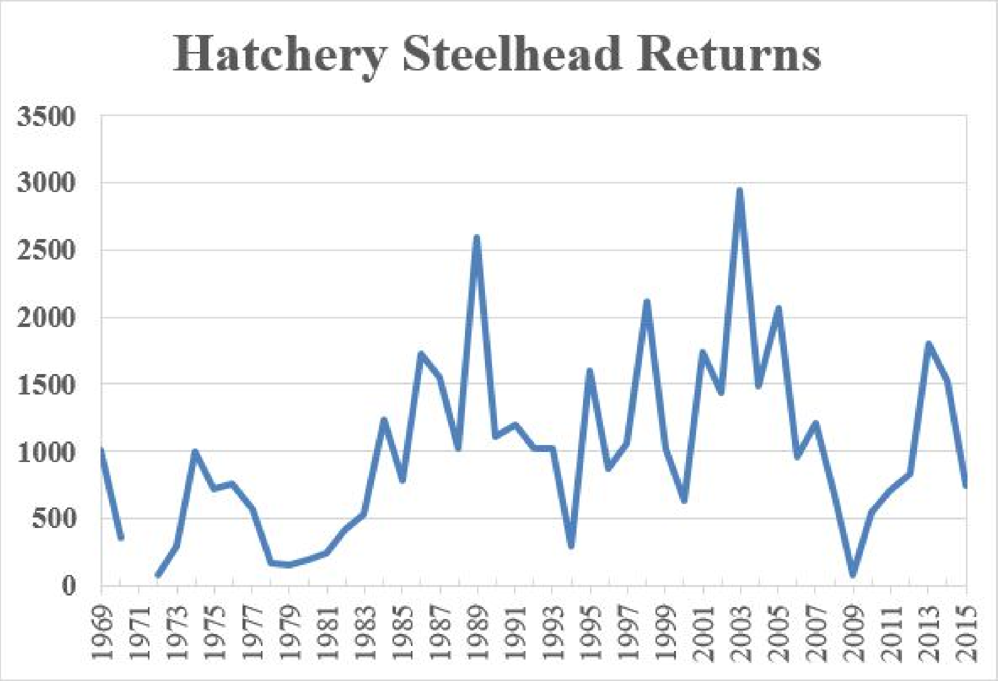

Figure 6. Adult CCV Steelhead Returns to FRFH, 1969-2015.

The FRFH was designed and is operated to replace CCV reduced steelhead production, attributable to the construction of the Oroville Facilities. The population of fish produced in the FRFH is artificially maintained. The FRFH has an annual production goal of 400,000 yearling CCV steelhead to mitigate for construction of the Oroville Facilities. The FRFH also has a goal of raising an additional 50,000 CCV steelhead for the Delta Fish Agreement (also known as the Four Pumps Agreement) between DWR and DFW, which addresses impacts from SWP pumping in the Delta. More than 99 percent of the CCV steelhead that enter the FRFH fish are of direct hatchery origin (Brown *et al.* 2004). The NMFS 2011 status review of CCV steelhead discussed that currently, nearly all the CCV steelhead that return to the Feather River Hatchery are hatchery fish. Ideally, hatcheries and management programs could seek to foster viable, independent populations of CCV steelhead across the CV, with the Feather River playing an integral role. Improved water management practices and habitat restoration may help better establish a viable population of naturally spawning CCV steelhead in the Feather River. Currently, the population of CCV steelhead in the Feather River appears to be largely hatchery-dependent, making progress toward long-term diversity challenging.

Data on the population of naturally produced CCV steelhead in the Feather River does not exist. There is no specific target set for adult abundance. Currently, the CCV steelhead population in the Feather River appears to be almost totally dependent upon the FRFH, placing even more importance on proper hatchery management and habitat restoration. The viability of this population will remain heavily dependent upon the hatchery until hatchery genetic management plans are fully implemented and natural origin CCV steelhead are replacing themselves at a sustainable level.

2.4.1.3 Southern DPS of North American Green Sturgeon

Green sturgeon are long-lived and widely ranging across the North American west coast, but the southern distinct population segment (sDPS) breeds exclusively in the freshwater rivers of California, predominantly in the Sacramento River, and to a smaller extent in the Feather and Yuba rivers. The best available information shows that access to historic sDPS green sturgeon habitat upstream of the Fish Barrier Dam in the Feather River that may have been used by sDPS green sturgeon is now blocked due to the construction of Oroville Dam (NMFS 2005). Southern DPS green sturgeon are now limited to downstream habitat, primarily below the Thermalito Afterbay Outlet, although some usage as far upstream as the Fish Barrier Dam has been observed. This loss of potential upstream habitat, subsequent downriver limitations, altered hydrograph and temperature regime, diversions of water, degraded environmental or habitat conditions, as well as overfishing, poaching, predation, ocean survival have greatly impacted the sDPS green sturgeon in the Feather River. This has resulted in in low abundance and future uncertainty for the species. In this section, we focus on sDPS green sturgeon usage of the Feather River, which contains at least one known spawning area (Figure 6) and also provides for a migratory corridor to access the Yuba River.

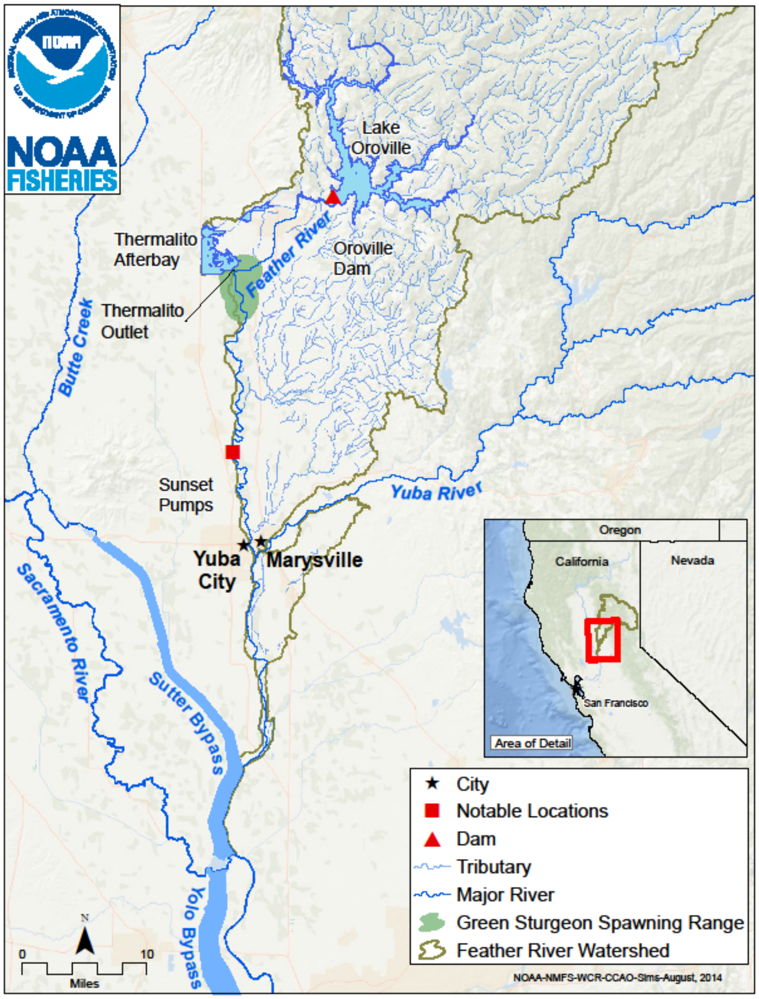

Figure 7. Feather River sDPS Green Sturgeon spawning areas.

An initial abundance estimate of the sDPS of green sturgeon was published in 2015. Several researchers (Klimey *et al.* 2015; Mora *et al.* 2015) identified estimates of an average run size of 364 adult sDPS green sturgeon to the Sacramento River, and a preliminary population estimate of 1,348 adults (± 524 individuals) (NMFS 2015) in the green sturgeon sDPS. This does not include Feather River fish. Ongoing work being conducted by UC Davis is seeking to refine the estimates. Initial indications are that the population estimate may increase. Researchers at UC Davis, most notably Ethan Mora, have surveyed the Sacramento River for sDPS green sturgeon and have been able to determine spawning locations and abundance of adult spawners in the river. So far, the work done by UC Davis has not included the Feather River in their annual sampling for adult sDPS green sturgeon, so the population numbers derived so far may be slightly underestimating the CV sDPS green sturgeon adult population size. There is an estimated average of 364 adult fish spawning in the Sacramento River per year (Klimley *et al.* 2015; NMFS 2015) and an estimated 25 or fewer sDPS green sturgeon utilizing the Feather River per year.

Nevertheless, the Feather River is highly valuable from a sDPS green sturgeon conservation perspective because it is the *only* place outside the Sacramento River where sDPS green sturgeon spawning has been documented, giving the Feather River a prominent role in the recovery of the species. In 2011, sDPS green sturgeon spawning in the Feather River was observed at the Thermalito Afterbay Outlet (Seesholtz *et al.* 2014). There is no available data on sDPS green sturgeon productivity in the Feather River. Spawning occurs episodically and opportunistically, as a function of suitable environmental conditions that presumably do not occur every year. The population growth rate is unknown. The population structure is unknown, and the relationship of spawner success in the Feather River to spawner returns (in the Feather River or Sacramento River) is also unknown. It will take at least a couple of decades to get this type of data, given the long life span of sDPS green sturgeon and the age at maturity. However, this would be valuable data to obtain so that a population trajectory can be determined.

Data for sDPS green sturgeon habitat in the Feather River and sDPS green sturgeon habitat interactions is limited. The number of adult green sturgeon in the Feather River is likely dependent on flow conditions and associated passage issues. In low flow years, it is likely that no sDPS green sturgeon migrate upstream of Sunset Pumps, and in the past Shanghai Bench was also a passage barrier. Within the Feather River, green sturgeon require adequate food resources and a migratory corridor to access spawning grounds and to access other tributaries such as the Yuba River. Water depth available in pools appears to be important. Pool depths of greater than 5 m appear important for holding and spawning. Sediment quality must be sufficient for all life stages. Acoustic data sets should improve in the coming years as sample sizes increase and the effects of tagging are no longer factors. As fish tagged in previous years return to the river, we may begin to get a feel for the range of behaviors that sDPS green sturgeon naturally exhibit as they use the Feather River. For the time being, we must simply assume that sDPS green sturgeon may use the Feather River for as little as a few days or as long as several months, and with sufficient flow to access the entire river, especially for passage at Sunset Pumps, we may see the full range of behavioral characteristics.

Southern DPS Green sturgeon distribution in the Feather River appear to be heavily influenced by flow rates. High springtime flows may provide environmentally attractive cues to sDPS green sturgeon and may encourage their migration up the Feather River. High flows are also necessary to achieve passage at Sunset Pumps in the Sutter Extension Water District (SEWD) (Figure 7), where a manmade rock weir stretches across the entire river, denying access to upriver spawning habitat until flows are sufficient for sDPS green sturgeon to pass over and above this impediment. Discussions, unrelated to the Oroville Facilities, are ongoing to address the effects of the Sunset Pumps weir on anadromous fishes.

Figure 8. Photo of the Boulder Weir at Sunset Pumps.

Given that the Fish Barrier Dam is likely to persist into the foreseeable future as a total migration barrier to sDPS green sturgeon, the habitat below the Fish Barrier Dam becomes the sole focus for sDPS green sturgeon conservation in the Feather River. Unlike Chinook salmon or CCV steelhead, there is not a hatchery for sDPS green sturgeon to mitigate the impacts to the species. Therefore, the condition of the Feather River below Oroville Dam is of utmost concern for the conservation of sDPS green sturgeon. Attention is focused upon water releases from Oroville Dam sufficient to provide suitable flows and temperatures. Additionally, habitat conditions necessary to support a healthy population of sDPS green sturgeon in the Feather River are influenced by a variety of other impacts such as sport fishing regulations, water diversions, contributions from tributaries such as the Yuba River, levee maintenance and construction, and so forth. All these factors should be managed in order to promote habitat conditions in the Feather River that support a viable sDPS green sturgeon population. Presently, most, if not all, of these factors are at levels that are insufficient to achieve sDPS green sturgeon viability.
The long-term viability of sDPS green sturgeon is potentially impacted by three important types of factors: 1) catastrophic events; 2) long-term demographic processes; and 3) long-term evolutionary potential.

In terms of catastrophic event risk, sDPS green sturgeon in the Feather River are at high risk. With only one known spawning location in the Feather River at the Thermalito Afterbay Outlet, a single catastrophe or environmental change (manmade or natural) that damages this habitat or affects the fish in this location could have a significant detrimental effect on the sDPS green sturgeon using the Feather River. During site visits to the Feather River in 2014, the characteristic voluminous discharge flow of water out of Thermalito Afterbay Outlet, which creates the hydrologic conditions that sDPS green sturgeon apparently favor, was absent, raising concerns that operational changes in water flow might be precluding sDPS green sturgeon spawning. However, it is unknown whether sDPS green sturgeon would relocate to another location or return to the ocean without spawning should a catastrophic event occur.

Drought conditions in California from 2012-2015 have also taken their toll, and the flows in the Feather River have not been adequate to permit unimpeded sDPS green sturgeon passage at Sunset Pumps. We know that elevated flows in the Sacramento River are important for sDPS green sturgeon, where higher river flows have been shown to be important for triggering adult migrations, spawning and play a role in juvenile recruitment.

In the Sacramento River, spawning is believed to be triggered by increases in water flow to about 14,000 cfs (average daily water flow during spawning months: 6,900 – 10,800 cfs; Brown 2007). In other rivers, post-spawning downstream migrations are triggered by increased flows. For example, in the Sacramento River migration flows range from 6,150 –14,725 cfs in the late summer (Vogel 2005), and in the Rogue, Klamath, and Trinity rivers flows greater than 3,550 cfs in the winter were identified (Erickson *et al.* 2002, Benson *et al.* 2007). Good recruitment of juvenile sDPS green sturgeon in the Delta was observed during years where the mean monthly February through May flows ranged from 3,488 – 20,505 cfs at Gridley, and 7,028 – 35,234 cfs at Nicolaus (USFWS 1995b). The current suitability of habitat in the Feather River is almost entirely dependent on releases from Oroville Dam, and the continued operations of Oroville Dam are likely to further attenuate high flow events.

Southern DPS green sturgeon critical habitat is much degraded in the action area. Within the Feather River habitat quality and quantity is an important issue for sDPS green sturgeon viability. Within this context, the most problematic issue for sDPS green sturgeon is probably flow. Oroville Dam, and to a lesser extent other upstream dams, impound flows that would otherwise have naturally flowed down the river during winter and spring storms, and with spring snow melt, flows which provided the necessary environmental cues for sDPS green sturgeon to migrate up the Feather River in search of spawning grounds. In the absence of these flows, sDPS green sturgeon appear to underutilize the Feather River. Furthermore, migration barriers such as the boulder weir at Sunset Pumps sturgeon passage at low flows, thereby exacerbating the problem of low flows.

The migratory PBF is also problematic as the habitat in the Lower Feather River is heavily impacted by unscreened water diversions that impose a potential serious mortality risk for larval and juvenile sDPS green sturgeon. Past investigations of suitable deep pools indicate that there are up to 12 deep holes over 13 miles, from the Fish Barrier Dam at RM 67 downstream to RM 54, with characteristics attractive to sDPS green sturgeon. Seven of these holes are greater than 5 meters deep, and five of the pools are between 3 – 5 meters. One of these holes is located directly downstream below the Thermalito Afterbay Outlet and may have been created or enhanced by releases from the Outlet. The total area of the pools is greater than 164,500 m^2. The adequacy of other PBFs for sDPS green sturgeon is unknown because little investigation has been done thus far to look at food resources, contaminants, or sediments in the Feather River.

2.4.2 Factors Affecting Species and Critical Habitat in the Feather River

As an integral part of the California SWP, the Oroville Facilities are operated in coordination with the Federal CVP to provide water deliveries to a large portion of California. Oroville Dam, its associated structures, and the operation of these structures and facilities induce factors and effects to listed fish species and their critical habitat. Oroville Dam retains sediment and large woody material that would otherwise wash downstream and replenish spawning and rearing habitat. The FRFH also has effects upon listed fish species through several mechanisms. These and other factors are considered below.

2.4.2.1 Blocked Habitat

Oroville Dam imposes a total barrier to migration at the point of the Fish Barrier Dam structure, which marks the terminus of river accessibility to anadromous fishes. For the fish species that historically utilized the upper Feather River, their descendants have suffered one of three fates: they are now permanently trapped above Oroville Dam, they have been extirpated from the river entirely, or they are forced to use the remaining habitat below the Fish Barrier Dam. Even if fish passage were provided past the Oroville Facilities, loss of access to historical spawning and rearing habitats upstream of the Oroville Facilities would probably continue somewhat into the foreseeable future due to the significant number of upstream hydroelectric projects that start at the upstream extent of the project facilities at Oroville Reservoir and extend into the upper watersheds of all main forks of the Feather River and their tributaries.

Downstream of Oroville Dam, near the town of Live Oak, SEWD operates a pumping facility known as Sunset Pumps. In order to raise the surface elevation of the river to allow the pumps to function properly, the SEWD maintains a boulder weir that stretches across the river. This structure does not have an engineered fish ladder or fish passage chute specifically designed for the passage of CCV steelhead, Chinook salmon, or sDPS green sturgeon. Because this structure blocks, or partially blocks, fish passage at low to moderate flows, the structure impacts listed fish species and contributes to their status in the Feather River.

2.4.2.2 Altered River Flow

The operation of Oroville Dam creates thermographs and hydrographs that are markedly different from the historical (pre-dam) condition of the Feather River (Figure 8). There is a consistent pattern of decreased springtime flows and increased summer flows across all water-year types. Marchetti and Moyle (2001) identified that restoration of natural flow regimes is necessary to reverse the decline of native fish populations. Healey (1991) stated that dams have probably had a much greater effect on stream-type Chinook salmon (*e.g.* CV spring-run Chinook salmon) than ocean-type Chinook (fall-run Chinook) due to longer migrations and longer resident times in rivers. The NRC (1996) stated that salmon are very sensitive to changes in streamflow and time their life-cycle movements according to local discharge regimes. For fish species (*e.g.* Chinook salmon, green sturgeon) that evolved in conditions of elevated springtime flows, such an altered hydrograph may have a negative effect. In some conditions, such as drought, the altered hydrograph can be beneficial.

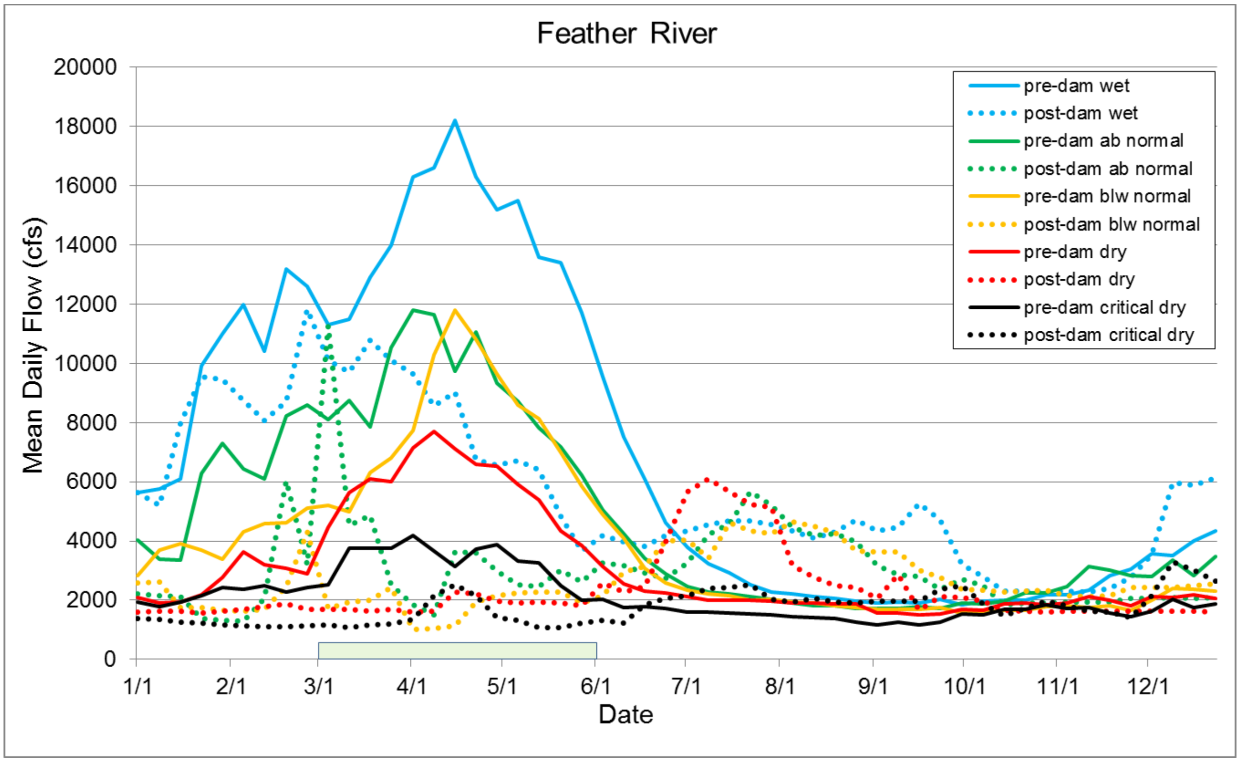

Figure 9. Median weekly water flow in critical dry water years in the Feather River during pre-dam years (Oroville gauge 1906 – 1965) and post-dam years (Gridley gauge 1969 – 2012).

DWR manages flows instream flows in the Feather River in a manner that reduces the potential for fish stranding and desiccation of redds. Minimum flows in the Feather River are currently set by an agreement between DWR and CDFW (DWR & CDFG 1983). The *Agreement Concerning the Operation of the Oroville Division of the State Water Project for Management of Fish and Wildlife* established criteria for flow and water temperature in the LFC and the reach of the Feather River downstream of the Thermalito Afterbay Outlet to the confluence with the Sacramento River to preserve salmon spawning and rearing habitat. The agreement specifies a minimum release of 600 cfs into the Feather River LFC from the Thermalito Diversion Dam for fisheries purposes. This is the total rate of flow from the diversion dam outlet, the diversion dam power plant, and the FRFH outlet.

When Lake Oroville surface elevation is greater than 733 feet, the minimum instream flow requirements on the Feather River, downstream of the Thermalito Afterbay Outlet, range from 1,000 – 1,700 cfs depending on unimpaired run-off forecasts. These flows are requirements in the existing project license. Under the DWR/DFG agreement, if the April 1 runoff forecast in a given water year indicates that, under normal operation of the SWP, the reservoir level will be drawn down to elevation 733 feet (approximately 1.5 million acre feet [af]), releases for fish life prescribed in the agreement (*i.e.*, the minimum instream flow requirements on the Feather River downstream of the Thermalito Afterbay Outlet) may suffer monthly reductions in the same proportion as the respective monthly reductions imposed upon deliveries of water for agricultural use from the SWP. However, in no case shall the fish water releases prescribed in the agreement be reduced by more than 25 percent.

Under the DWR/DFG agreement, if the hourly flow exceeds 2,500 cfs anytime between October 15 and November 30, DWR must maintain a flow equal to that hourly flow amount less 500 cfs until the following March unless the high flow was a result of flood management operations or mechanical problems. This requirement ensures flow levels are high enough to keep the overbank areas submerged to protect any fish spawning that could occur. In practice, the flows are maintained below 2,500 cfs from October 15 to November 30 to prevent fish from spawning in the overbank areas.

2.4.2.3 Altered River Temperatures

The operation of Oroville Dam and associated facilities affects water temperature in the Feather River below Oroville Dam. Water temperatures may be colder or warmer than historic norms in the river depending upon a number of parameters including the large, naturally occurring variability in Feather River hydrology (unimpaired Feather River flow has varied from 1 million af to nearly 10 million af over the roughly 100-year gauge record), operation of dams further upstream, and a variety of operations conducted at Oroville Dam, a majority of which are not elective for DWR.

DWR releases water from Lake Oroville under a prescribed statutory and contractual hierarchy. These are, in order of priority: flood control releases, Feather River instream flow and temperature requirements (primarily the result of biological opinions), Delta water quality requirements (permit conditions associated with DWR's water rights on the Feather River), contractual water supply obligations to senior Feather River water rights diverters, and lastly, SWP water supply deliveries to the 29 public agencies with SWP water supply contracts. Power generation releases through Hyatt Powerplant and releases through the River Valve Outlet System from Lake Oroville are made subordinate to the hierarchy noted above. These priorities may be adjusted in specific situations if rigid adherence to them would compromise the ability to meet legally mandated water quality, flow, or temperature requirements in other parts of the river system.

With respect to the Hyatt Powerplant intake located just upstream of the left abutment of Oroville Dam, water can be drawn from Lake Oroville over a range of depths by adding or removing shutters on the Hyatt Power Plant intake, thus permitting water to be drawn into the turbines over all or limited intervals of the upper 287 feet of Lake Oroville. Because Lake Oroville stratifies with respect to temperature, especially during summer, deeper water below the thermocline tends to be colder. The Hyatt Intake is very effective, under most operating conditions, at regulating the temperature of the water released from Oroville Dam to meet all current Oroville Facilities temperature requirements. Essentially, Lake Oroville must approach elevation 700 feet or lower for the Hyatt Intake to be ineffective in drawing cold water below the Lake Oroville thermocline. Such low elevation at Lake Oroville is typically only reached in dry or drought conditions or when such conditions persist over several years.

As water flows downstream of Oroville Dam, most water is typically diverted into the Thermalito Forebay-Afterbay Complex to meet the aforementioned senior Feather River water rights obligations, which are primarily for agricultural use. A substantial portion of the April to

October releases from Oroville Dam is for this purpose. By design, the water residence time in the relatively shallow 40,000-acre Thermalito Afterbay warms the water. On average, about one-third of this water flows back into the Feather River at the Thermalito Afterbay Outlet. The diversion of water through the Thermalito Complex can warm the water as much as 6°F. Thermalito Afterbay was originally designed, in part, to warm the river water downstream to mimic the warmer water temperatures that occurred in the Feather River before Oroville Dam was constructed (and before its cold water pool was established). Oroville Dam operations provide colder water to the Feather River, under a broad range of hydrologic conditions, compared to the pre-Oroville Dam conditions. Warmer river water is more conducive to rice farming, which has been identified as a beneficial use of Feather River water since before the Oroville Facilities were built as recognized in the senior water rights along the Feather River.

The operation of Oroville Dam and associated facilities produce complicated effects upon water temperature in the Feather River below Oroville Dam. Water temperatures may be colder or warmer than historic norms in the river depending upon how operations are conducted. Within Lake Oroville, water can be drawn from a variety of depths by adding or removing shutters on the Hyatt Power Plant intakes. Because deeper water tends to be colder, this type of manipulation is effective, up to a point, at regulating the temperature of the water released from Oroville Dam. The dam structure has river valves that allow deep, cold water to be released if desired. However, the diversion of water through the Thermalito Complex significantly reduces the amount of cold water habitat available in the Feather River. Furthermore, pump back operations[1] can also contribute to the artificial warming of river water.

Additionally, other FERC-licensed projects in the upper Feather River can influence the water temperature in the FRFH and the LFC. The South Feather Power Project discharges water in the Lower Feather River immediately downstream from Oroville Dam and affects water temperatures at the FRFH and the LFC. Water is diverted from the South Feather River at Ponderosa Dam and conveyed via tunnel and conduit to Miner's Ranch Reservoir and then via tunnel and penstock to the Kelly Ridge Powerhouse, through which up to 260 cfs is discharged to the Feather River downstream of Oroville Dam. Data and analyses indicate the flows diverted at Ponderosa Dam experience heating in transit to the Kelly Ridge Powerhouse, especially within Miner's Ranch Reservoir. The temperatures of the Kelly Ridge discharges are of greatest concern from summer through fall (August through October) because: (1) this interval is critical for anadromous fish holding, spawning, and incubation in the Feather River; (2) the intake of water to the Feather River Hatchery occurs from the Thermalito Diversion Pool, and cold water requirements must be maintained; (3) colder releases through the Hyatt Powerhouse (Oroville Project) are reduced or periodically halted as Lake Oroville elevations fall in late summer and fall, and as consumptive needs and power demands lessen; and (4) late summer or fall

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[1] Overall, the SWP uses more energy than it produces. Pump-back operations allow DWR to minimize the cost of the power it purchases. Pump-back operations are a practice where water is pumped from an afterbay (*e.g.*, Thermalito Afterbay) up to a forebay (*e.g.*, Thermalito Forebay or the Diversion Pool) during off-peak periods when power costs are lower. The water is then sent back through the power plant to generate power when power values are higher to offset the costs of water conveyance. A side effect of this practice is the warming of the water due to its retention time in the system. When the water eventually does exit the system at the Thermalito Afterbay, it is likely warmer than it would have been had it been initially discharged from Lake Oroville.

meteorological conditions (heat storms) may cause appreciable heating in the FRFH and the LFC.

Collectively, all these operations may produce a thermograph that is similar or different to that in which ESA listed anadromous fish species evolved (Figure 9). A variety of temperature control devices have been engineered into the Oroville Facilities, allowing DWR to adjust river temperatures to better suit the needs of listed fish species. DWR has been able to substantially reduce river temperatures from approximately May 1 until November 1 compared to pre-dam conditions. This type of temperature control was not available before the Oroville Facilities were built.

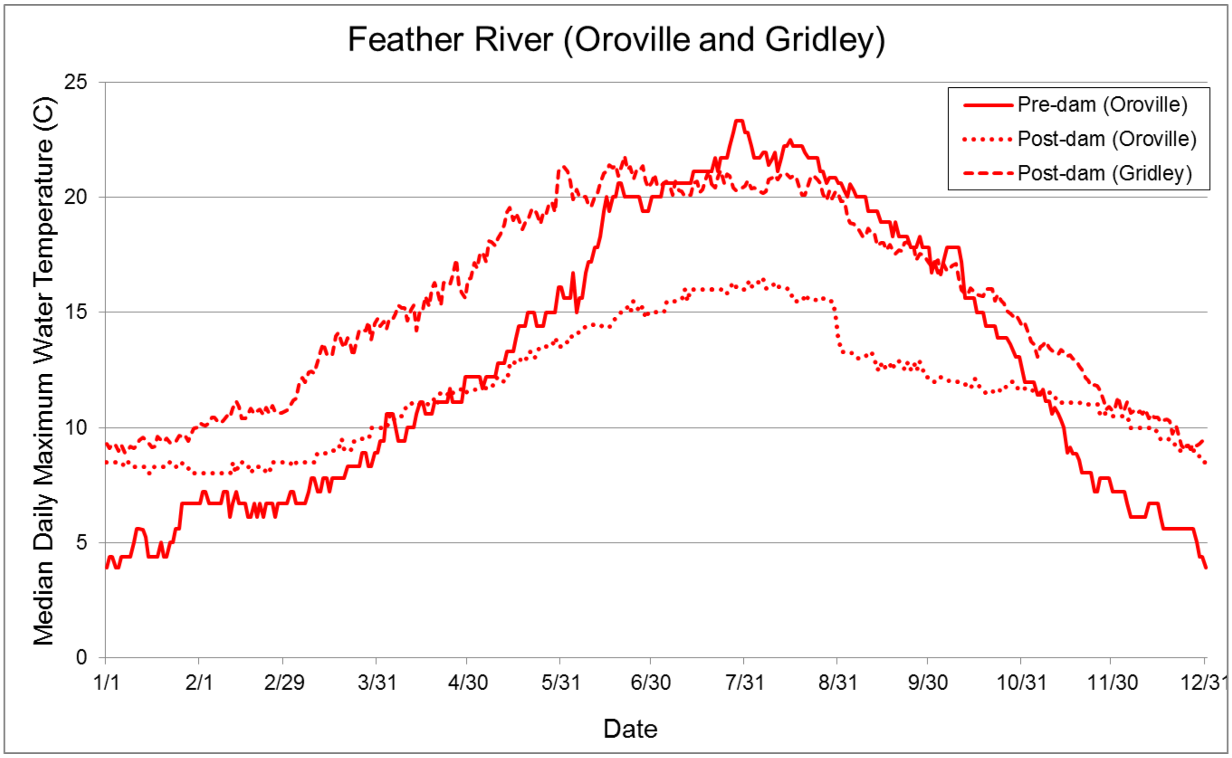

Figure 10. Median daily maximum water temperature in the Feather River at Oroville during pre-dam years 1958-1967, at Oroville during post-dam years 1969-1992, and at Gridley during post-dam years 2002-2012.

Currently, water temperatures in the Lower Feather River are capable of supporting sDPS green sturgeon spawning during much of the spawning period, including what is considered the peak spawning period in April and May. From 1964 to 1994, water temperatures were within the optimal range for spawning 99 percent of the time from March through April from RM 67 downstream to RM 38.9 at the Sunset Pumps, a distance of approximately 28 river miles. During May, approximately 16 miles of habitat are within optimal ranges for 95 percent of the days during that period. Daily average water temperatures tend to be warmer in June, but are within optimal ranges for 88 percent of the days in June at RM 54 and up to 82 percent of the days at the Gridley Bridge (RM 51). During wet and above average years, the conditions are slightly improved when optimal spawning temperatures in June are exceeded for only 11 to 15 percent of the days downstream to RM 54 and 51, respectively (DWR 2009).

2.4.2.4 Impaired Recruitment of Large Woody Material (LWM) and Sediment

Oroville Dam blocks important physical transport mechanisms, most notably the inhibition of downstream transport of gravel and large woody material. Gravel transport is important for the maintenance of favorable spawning habitat. Without human intervention, the habitat below Oroville dam becomes increasingly devoid of suitable spawning substrates as this material is washed downstream during periods of heavy flow and is not replaced naturally. Therefore, a gravel augmentation program, though expensive and labor intensive, is the only way to maintain suitable spawning habitat below Oroville Dam.

Continued deprivation of the sediment load in the lower Feather River is expected to result in reduced formation of sediment benches important to the colonization and succession of riparian vegetation (DWR 2007). Riparian vegetation is important to aquatic habitats because it provides overhanging cover for rearing fish, stream side shading, and a source of terrestrial and aquatic invertebrate contributions to the fish food base (DWR 2007). Riparian vegetation is also an important source of future LWM contributions to the aquatic system. LWM is important for maintaining habitat complexity, and providing refuge areas for juvenile fishes (salmonids and sturgeon) and for creating habitat that encourages a complex and thriving ecosystem, ideally one that is hospitable to native fishes.

2.4.2.5 Susceptibility to Disease

A number of factors, such as fish species, fish densities, the presence and amounts of pathogens in the environment, and water quality conditions (*e.g.,* temperature, DO, and pH), relate to the susceptibility of listed species to disease within the action area. Oroville Facilities, and associated programs, have affected all these factors since operations began and are expected to continue to do so into the foreseeable future.

Several endemic salmonids pathogens occur in the Feather River basin, including *Ceratomyxa shasta* (salmonids ceratomyxosis), *Flavobacterium columnare* (columnaris), the infectious hematopoietic necrosis virus (IHNV), *Renibacterium salmoninarum* (bacterial kidney disease), and *Flavobacterim psychrophilum* (cold water disease) (DWR 2004b). Although all these pathogens occur naturally in the Feather River basin, the Oroville facilities may have produced environmental conditions that are more favorable than under historical conditions. Such conditions include: 1) impediments to upstream migration altering timing, frequency, and duration of exposure of anadromous salmonids to certain pathogens; 2) inadvertent introduction of foreign diseases through out-of-basin transplants as part of the Lake Oroville Coldwater Fishery Improvement Program; 3) the transmission of disease from FRFH fish to wild or natural populations of listed salmonids; and 4) water transfers, pump-back operations, and flow manipulation resulting in changes in water quality conditions (*e.g.,* temperatures, DO, pH, etc.). Across the entire CV, including the Feather River, there is no evidence that CV spring-run Chinook salmon have experienced unusual levels of disease in the wild. There have been numerous outbreaks of IHNV in Chinook salmon at the FRFH. Although the virus has been detected in stream salmonids, there have been no reported epizootics of IHNV in Central Valley stream populations (*i.e.*, the virus was detected but the fish themselves were asymptomatic of the disease) (DWR 2009). It appears that IHNV is not readily transmitted from hatchery fish to salmon and other fish in streams, estuary, or the ocean (DWR 2009).

2.4.2.6 Water Quality

Water quality parameters that may affect fish species within the Feather River basin include: (1) DO and pH; 2) turbidity and total suspended solids (TSS) levels; (3) metals, petroleum by-products; (4) pesticide concentrations; and 5) nutrient concentrations. The CVRWQCB has listed the lower Feather River as impaired by sources of mercury, certain pesticides, and toxicity of unknown origin (DWR 2007).

Findings and other pertinent information related to monitored water quality parameters have been reported by DWR (2004b). For the most part, DO and pH levels complied with objectives established by the CVRWQCB. Turbidity and TSS levels were typically low in the upper watershed (above Lake Oroville), except during storm events. Because Lake Oroville acts as a sediment trap, turbidity and TSS levels are also generally low between Oroville dam and the Thermalito Afterbay Outlet. Downstream of the Thermalito Afterbay Outlet, turbidity and TSS concentrations generally increase, presumably related to inputs from downstream tributaries in the lower Feather River (DWR 2007).

Exceedance of water quality objectives for aluminum, iron, and copper were observed in DWR’s water quality studies (DWR 2004b), but could not be associated with project operations or recreational activities. Petroleum products and pesticides were largely undetected in water samples collected for DWR’s studies (DWR 2007). Nutrient concentrations measured in the Feather River were consistently below most Basin Plan objectives for the protection of beneficial uses (which includes freshwater habitat, fish migration and spawning) (DWR 2007).

The Feather River system has a large amount of associated mine dredge tailings and the project area represents a small percentage of the total. A percentage of the existing dredge tailings in the project area have been excavated and removed as part of the construction of Oroville Dam. Under existing conditions, water currently inundates and washes out of the project area. No new areas of dredge tailings will be inundated as a result of the project. Reducing stage and velocities along the reach between the inflow and outflow weirs will decrease the potential for mercury loadings from the dredge tailings in this reach, particularly where there are unvegetated dredge tailings near the top of steep slopes. A percentage of the existing dredge tailings in the project area have been excavated and removed as part of the construction of Oroville Dam.

It is expected that water quality parameters will continue to be monitored by the CVRWQCB and may remain at current levels into the foreseeable future.

2.4.2.7 Water Diversions

DWR has settlement agreements with six local agencies along the Feather River (including the Thermalito Afterbay) from Lake Oroville to the confluence with the Sacramento River. They receive water according to the terms of settlement stemming from the original construction of the Oroville Facilities. These settlements recognized the senior water rights of those agencies and that DWR would provide them certain quantities of water from storage in Lake Oroville in accordance with those senior water rights. Four of these agencies are allowed to divert up to 955,000 AF during the irrigation season (April 1 – October 31), subject to provisions for reduction in supply under certain specific low-inflow conditions. The agreements with these agencies also indicate that an unspecified amount may be diverted for beneficial use outside of the contract irrigation season (November 1 – March 31). The remaining two agencies are allowed to divert up to 19,000 af annually, subject to provisions for reduction in supply under certain specific low-inflow conditions.

The actual amount diverted varies from year to year depending on the local hydrology. These diversions are made at one location in Lake Oroville, one location in the Thermalito Power Canal, four locations in Thermalito Afterbay, and five locations on the Feather River below Thermalito Afterbay. The agencies that divert directly from the Thermalito Afterbay are collectively referred to as the Feather River Service Area water users and are responsible for most of the local diversions. DWR has also executed a number of contracts with riparian landowners along the Feather River downstream of Oroville Dam. Riparian owners are entitled to divert unimpaired flow for use on riparian land, but are not entitled to augmented flow made available as a result of project storage. Although the quantities of water are relatively small and do not ordinarily influence SWP operations, in certain years, riparian diversions can affect Oroville releases.

Water diversions have the potential to affect listed fish species in two ways: first, by entraining fish directly, and second, by altering the habitat through changes to water flow, temperature, hydrology, or by creating predation hotspots. Entrainment risk is primarily a concern for water diversions that are unscreened and fry and juvenile life stages are most vulnerable. An unscreened water diversion can entrain a fish by sucking it up into the pump, where it might be killed or injured by the pump, or, should the fish survive transport through the pump, it will be transported to a canal or ditch where long-term survival is probably impossible. Entrainment experiments have shown that a juvenile Chinook salmon's entrainment risk ranges from 0.3 to 2.3 percent and a juvenile green sturgeon's entrainment risk ranges from 4.2 to 22.3 percent when encountering a single unscreened pump (Mussen *et al.* 2014).

Risk of entrainment varies by year and location and can be significantly affected by river velocity, the rate of water diversion, and the number of pumps encountered during migration (Mussen *et al.* 2014). On the Feather River there are 120 diversion pumps downstream of the Fish Barrier Dam, only four of which are screened (Figure 10). The unscreened diversions pose a potential entrainment risk to both larval and juvenile fishes. The combined effect of all unscreened water diversions is unknown and requires further study. Additionally, NMFS should develop screen criteria for green sturgeon because the current application of salmonid criteria may not be sufficient to protect sDPS green sturgeon.

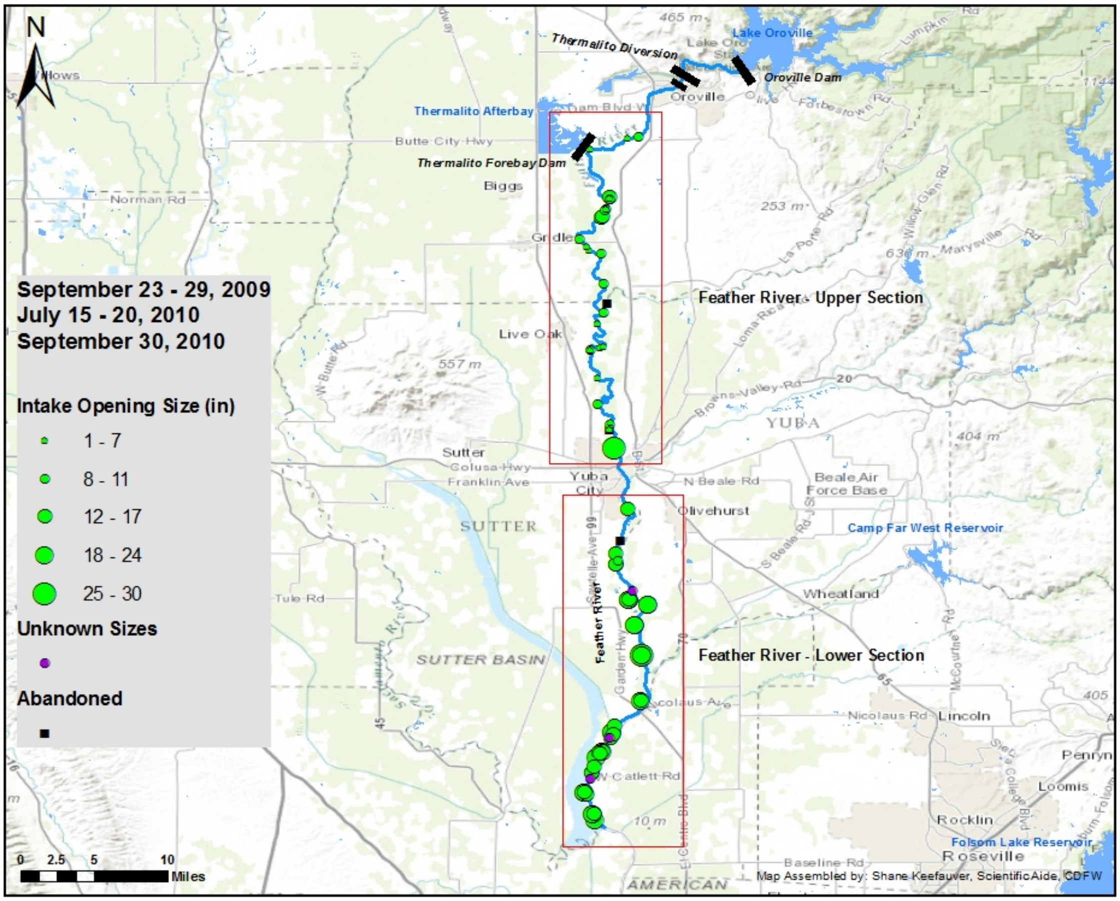

Figure 11. Locations of water diversions in the Feather River. Of the approximately 120 water diversions in the lower Feather River, only four are screened.

Periods of high water diversion may result in low flows along the Feather River. Salmon, steelhead, and green sturgeon are attracted by increased flows, so low flows in the Feather River may be insufficient to provide attraction cues to these fish species, thereby inhibiting spawner returns. Low flows may also lead to higher in-river water temperatures, perhaps to sub-optimal levels. Low flows may also expose barriers to migration at locations such as the Sunset Pumps, where a boulder weir stretches across the river, inhibiting fish passage at low to moderate flows (the exact flow thresholds that pose a fish passage problem at the Sunset Pumps boulder weir is not yet clearly defined).

The cumulative impact of water diversions to listed fish species in the Feather River is not well understood. The SWRCB Division of Water Rights regulates water diversions through their Water Rights Permitting program in coordination with CDFW. Recently, the SWRCB has stepped up monitoring requirements due to the drought, requiring reporting of diversion amounts and ceasing diversions when precipitation and other factors limit available flows. In addition, there are currently proposed emergency regulations for measuring and monitoring water diversions through Senate Bill no. 88 (SB88). SB88 authorizes SWRCB to adopt regulations requiring measurement for water right holders and claimants who divert 10 af of water or more per year. Currently, the effects are not being analyzed. Therefore, this topic presents an opportunity to engage in better management, and thereby improve habitat conditions in the Feather River, which may help to bolster spawner success, recruitment, escapement and overall abundance of salmon, CCV steelhead, and sDPS green sturgeon in the Feather River.

2.4.2.8 Flood Control

The Oroville Facilities are also operated as an integral component of the flood management system for areas along the Feather and Sacramento Rivers downstream of Oroville Dam. This flood management system is called the Sacramento River Flood Control Project. From September to June, the Oroville Facilities are operated under flood control requirements specified by the Corps, the agency primarily responsible for flood control operations. Historically, flood control releases have not been necessary every year. When they are necessary, however, they can be substantial. Peak flood control releases during major spill events between January 1970 and December 1996 ranged from 77,000 – 160,000 cfs (FERC 2007).

Flood control operations, such as bank modification through the construction of levees and bank armoring, has dramatically altered the geomorphic processes affecting the lower Feather River. Levees armored with riprap have constrained the river and simplified the hydrograph by reducing the frequency of bankfull and greater flows that shape and maintain the morphology of the river channel and associated fish habitats. These simplified habitat conditions have reduced the inundation of floodplain habitats which are known to improve the growth and survival of juvenile salmonids when compared to rearing conditions in the main channel (Jeffres *et al.* 2008).

2.4.2.9 Recreational Fishing

Fishing regulations currently prohibit fishing of any type above the Table Mountain Bridge on the Feather River, but limited fishing for CCV steelhead, salmon, and sturgeon is permitted below this bridge. While hatchery CCV steelhead, Chinook salmon, and white sturgeon are targeted, incidental catch of protected species such as naturally produced CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon does occur. The areas open to fishing includes some of the best spawning habitat for listed salmonids on the Feather River, introducing the possibility that spawning redds might be disturbed by anglers.

Since 1998, all hatchery CCV steelhead have been marked with an adipose fin clip, allowing anglers to tell the difference between hatchery and wild CCV steelhead. Current regulations restrict anglers from keeping unmarked CCV steelhead in CV streams, except in the upper Sacramento River.

Current sport fishing regulations do not prevent wild CCV steelhead from being caught and released many times over while on the spawning grounds, where they are more vulnerable to fishing pressure. Recent studies on hooking mortality based on spring-run Chinook salmon have found a 12 percent mortality rate for the Oregon in-river sport fishery (Lindsay *et al.* 2004). Applying a 30 percent contact rate for CV rivers (*i.e.*, the average of estimated CV harvest rates), approximately 3.6 percent of adult steelhead die before spawning from being caught and released in the recreational fishery. Studies have consistently demonstrated that hooking mortality increases with water temperatures. Mortality rates for steelhead may be lower than those for Chinook, due to lower water temperatures.

In addition, survival of CCV steelhead eggs is reduced by anglers walking on redds in spawning areas while targeting hatchery CCV steelhead or salmon. Roberts and White (1992) identified up to 43 percent mortality from a single wading over developing trout eggs, and up to 96 percent mortality from twice daily wading over developing trout eggs. Salmon and trout eggs are sensitive to mechanical shock at all times during development (Leitritz & Lewis 1980). Typically, CCV steelhead and salmon eggs are larger than trout eggs, and are likely more sensitive to disturbance than trout eggs. Currently, there are no regulations restricting river access to provide protection for spawning areas in the Feather River.

2.4.2.10 Global Climate Change

Global climate change is a broad-scale cumulative effect that is likely to affect the action area. The world is about 1.3°F warmer today than a century ago, and the latest computer models predict that, without drastic cutbacks in emissions of carbon dioxide and other gases released by the burning of fossil fuels, the average global surface temperature may rise by two or more degrees in the 21st century (IPCC 2001). Much of that increase likely will occur in the oceans, and evidence suggests that the most dramatic changes in ocean temperature are now occurring in the Pacific (Noakes 1998). Using objectively analyzed data Huang and Liu (2000) estimated a warming of about 0.9°F per century in the Northern Pacific Ocean.

Sea levels are expected to rise by 0.5 to 1.0 meters in the northeastern Pacific coasts in the next century, mainly due to warmer ocean temperatures, which lead to thermal expansion much the same way that hot air expands. This will cause increased sedimentation, erosion, coastal flooding, and permanent inundation of low-lying natural ecosystems (*e.g.*, salt marsh, riverine, mud flats) affecting listed salmonid and green sturgeon PBFs. Increased winter precipitation, decreased snow pack, permafrost degradation, and glacier retreat due to warmer temperatures will cause landslides in unstable mountainous regions, and destroy fish and wildlife habitat, including salmon-spawning streams. Glacier reduction could affect the flow and temperature of rivers and streams that depend on glacier water, with negative impacts on fish populations and the habitat that supports them.

Summer droughts along the South Coast and in the interior of the northwest Pacific coastlines will mean decreased stream flow in those areas, decreasing salmonid survival and reducing water supplies in the dry summer season when irrigation and domestic water use are greatest. Global warming may also change the chemical composition of the water that fish inhabit: the amount of oxygen in the water may decline, while pollution, acidity, and salinity levels may increase. This will allow for more invasive species to overtake native fish species and impact predator-prey relationships (Peterson & Kitchell 2001; Stachowicz *et al.* 2002).

In light of the predicted impacts of global warming, the CV has been modeled to have an increase of between +2° C and +7° C by 2100 (Dettinger *et al.* 2004, Hayhoe *et al.* 2004, VanRheenen *et al.* 2004), with a drier hydrology predominated by rainfall rather than snowfall. This will alter river runoff patterns and transform the tributaries that feed the Feather River watershed from a spring and summer snowmelt dominated system to a winter rain dominated

system. It can be hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival. The cold snowmelt that furnishes the late spring and early summer runoff will be replaced by warmer precipitation runoff, possibly affecting the ability to meet downstream water temperature objectives to protect salmon, steelhead, and green sturgeon. This will truncate the period of time that suitable cold-water conditions exist downstream of existing reservoirs and dams due to the warmer inflow temperatures to the reservoir from rain runoff. Without the necessary cold water pool developed from melting snow pack filling reservoirs in the spring and early summer, late summer and fall temperatures downstream of reservoirs, such as Lake Shasta, could potentially rise above thermal tolerances for juvenile and adult salmonids (*i.e.* Sacramento River winter-run Chinook salmon and CCV steelhead) that must hold and/or rear downstream of the dam over the summer and fall periods.
A reduction in snowpack combined with increased ambient air temperatures is expected to result in earlier melting of snow and less run-off from the snowpack than that which occurs today. This combined with more precipitation as rain will affect future operations of all reservoirs within the Feather River basin.

A change in the run-off pattern within the Feather River watershed will likely affect reservoir storage and downstream river flows due to more frequent spillway releases. Currently, summer water temperatures often are close to the upper tolerance limits for salmon and steelhead and any increase in ambient air temperatures as a result of climate change is anticipated to make it more difficult at the very least, if not impossible, to meet established water temperature objectives on the lower Feather River. Reduced reservoir storage as a result of the anticipated change in run-off pattern may also affect the availability of a cold water supply necessary to maintain river temperatures downstream.

Within the context of the brief period over which the proposed action is scheduled to be operated, however, the near term effects of global climate change are unlikely to result in any perceptible declines to the overall health or distributions of the listed populations of anadromous fishes within the action area that are the subject of this consultation.

2.4.3 Conclusion: Survival and Mortality

The survival prospects for listed fish species in the Feather River are not particularly good. Many of the above factors are the cause, plus a few additional topics, such as predation, that have not been covered thus because of insufficient information. In a recent study of spring-run Chinook salmon smolts released in the Feather River, smolts generally survived at a lower rate while traveling through the Feather River than the Sacramento River or Delta (Amman *et al.* 2014) (Figure 11). Specific reaches of the Feather River were identified by the investigators as trouble areas, or "mortality hotspots" (Figure 12) and may warrant further investigation. However, CWT data from paired releases of CV spring-run Chinook salmon smolts released in the river and in San Pablo Bay reveal relatively equal return rates as adults to the Feather River. Data from other years show that smolts released in the bay perform better, suggesting there are no clear answers regarding the survival of hatchery smolts released in the lower river

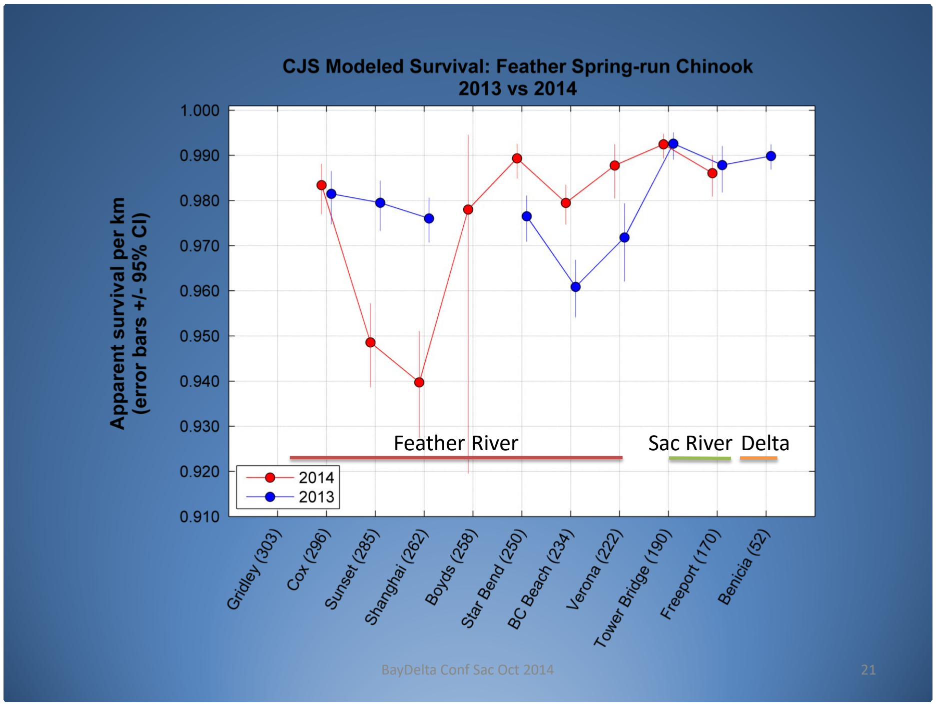

Figure 12. Study results of CV spring-run Chinook salmon smolt survival (2013-2014) where smolts were released in the Feather River, and survival tracked through the Feather River, Sacramento River, and the Delta. Survival was lowest in the Feather River. Source: presentation by Arnold Amman, NMFS/SWFSC, at the Bay Delta Science Conference, 2014.

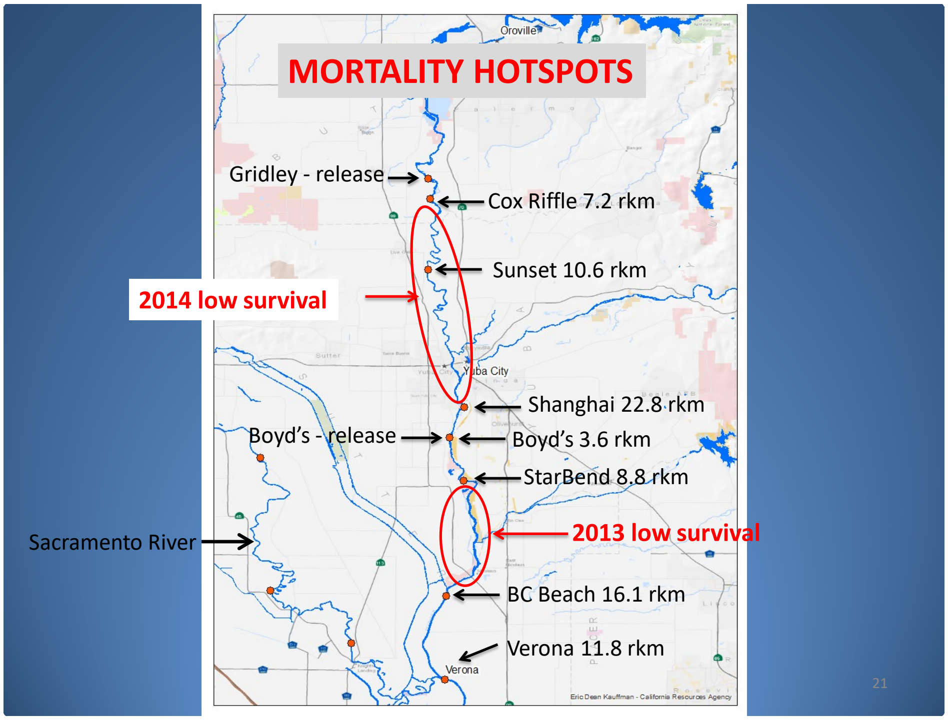

Figure 13. Mortality Hotspots in the Feather River, 2013-2014.

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 proposed action and are later in time, but still are reasonably certain to occur.

The effects assessment will consider the nature, duration, and extent of the effects of the proposed action relative to the migration timing, behavior, and habitat requirements of federally listed CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon and the magnitude, timing, frequency, and duration of project impacts to these listed species. Due to the life history timing of spring-run Chinook salmon, steelhead, and green sturgeon, it is possible for the following life stages to be present in the action area: rearing and emigrating juveniles, and spawning and migrating adults.

To evaluate the effects of the OWA Flood Stage Reduction Project, NMFS examined the potential proposed actions in the designated action area. We analyzed construction-related impacts and the expected fish response to habitat modifications. We also reviewed and considered SBFCA’s proposed conservation and mitigation measures. This assessment relied heavily on the information from SBFCA’s BA project description, site visits, and discussions with consulting biologists and project engineers.

Specifically, the assessment will consider the potential short-term impacts related to these species resulting from the construction impacts of the proposed action, including: 1) potential for contaminants hazardous materials entering the water; 2) increased turbidity and suspended sediment; 3) underwater noise; 4) potential mercury mobilization/methylation; 5) installation of a cofferdam and potential for fish stranding; and 6) temporal loss of riparian vegetation. Additionally, the assessment will consider the potential impacts to critical habitat and beneficial effects of improved connectivity of the Feather River to its historic floodplain, reduced flood stages within the main channel, more frequently inundated floodplain rearing habitat for juvenile salmonids, long-term increase in riparian vegetation, and reduction in the extent of invasive plant species.

2.5.1 Construction Impact Analysis

NMFS expects that adult and juvenile CV spring-run Chinook salmon, adult and juvenile CCV steelhead, and adult and juvenile sDPS North American green sturgeon may be present in the action area during construction activities. Spawning habitat does not occur within the action area; therefore, adverse effects to incubating eggs are not expected to occur. Construction activities will likely cause localized, temporary disturbance of aquatic habitat. Short-term effects are assessed based on the potential for exposure of listed species to construction-related effects and general knowledge of the impact mechanisms and species responses to these effects.

Activity below the OHWM of the Feather River will have potential direct effects on listed fish species and would be limited to grading for the access improvements and construction of the notch connections to the river. All other construction and grading activities will be restricted to the upper portions of the levees (above the OHWM) and interior channels of the OWA D-Unit where no direct connection to the Feather River currently exists except during peak flood events. Only those fishes that are holding adjacent to or migrating past the construction site will be directly exposed or affected by construction activities. Those fishes that are exposed to the effects of construction activities will encounter short-term (*i.e.*, minutes to hours) construction-related noise, physical disturbance, and water quality impacts that may cause injury or harm by increasing the susceptibility of some individuals to predation by temporarily disrupting normal behaviors and affecting sheltering abilities. Adult salmonids generally avoid areas of construction activity; therefore, are not expected to be present.

Green sturgeon move to estuaries and the lower reaches of rivers between late winter and early summer, and ascend rivers to spawn in the spring and early summer. Adult green sturgeon leave the rivers soon after spawning (Environmental Protection Information Center *et al.* 2001), so are not expected to be present during the project work window. Movement and foraging during downstream migration occurs at night for both larvae (approximately 10 days post-hatch) and juveniles (73 FR 52084; Cech *et al.* 2000, as cited in USBOR 2008). Juvenile emigration reportedly occurs from May through September; therefore, juveniles are expected to be exposed to construction activities if present.

2.5.1.1 Fish Stranding Potential and Effects of Fish Capture and Handling

Ultimately, the proposed action is expected to improve conditions of the OWA D-Unit that have caused fish stranding in the past. Of the elements of the proposed action designed to reduce the risk of fish stranding (see Section 1.3.2 *Project Description*), the notch reconnection at the southwestern end of the OWA is the only proposed feature that may temporarily create fish stranding issues within its associated construction area. Based on the timing and location of cofferdam installation, juvenile steelhead are at highest risk of being stranded. The risk of stranding adult salmon or steelhead is low because of their preference for deeper offshore areas for holding and migration. Temporary cofferdams formed by steel sheet piles, earthen berms, or inflatable bladders may be required to facilitate construction of the new channel and installation of prefabricated box culverts. Installation of a cofferdam on the bank of the Feather River may result in stranding of fishes and potential mortality due to poor water quality and subsequent dewatering of the enclosed construction area. Isolation of the construction area before grading and other in-water activities is important for minimizing potential adverse effects of these activities on listed fish species and their habitat from equipment working in open water of the Feather River. Additionally, some degree of initial dewatering may be required to achieve the necessary conditions (*e.g.*, suitable water depths) for fish capture; under these conditions, dewatering operations may need to be temporarily suspended as needed to capture fishes before the site is fully dewatered.

To avoid or minimize the loss of fishes that may become stranded, a qualified fish biologist will be onsite before, during, and after cofferdam installation to determine the presence of fishes and identify appropriate methods for excluding, collecting, and/or relocating fishes from the affected area. Fish relocation will first be attempted using herding using block nets since this method is expected to have the lowest impact on fishes, as they will not be handled and will not be subject to holding and transport stress. If herding is not fully successful, other potential methods include capture and relocation using dip nets, seines, electrofishing, or a combination of these depending on site conditions. Netting, seining, and electrofishing require handling fishes, and thus will only be used when herding is not successful. Electrofishing, if authorized, will be conducted in accordance with NMFS electrofishing guidelines (NMFS 2000). It is critical that fish capture and relocation operations begin and are completed as soon as possible following isolation of the notch construction area to minimize potential predation and adverse water quality effects (*e.g.*, high water temperature, low DO) within the enclosed area. Although capture/relocation activities are expected to reduce overall losses, it is possible that not all fishes will be captured, and some incidental injury or mortality to small numbers of juvenile fishes is expected to occur as result of dewatering, capture, handling, and relocation.

2.5.1.2 Underwater Noise

Noise and vibrations from instream construction activities may impact adult and juvenile CV spring-run Chinook salmon, CCV steelhead, and green sturgeon. Direct effects associated with in-river construction work involve equipment and activities that produce pressure waves, creating underwater noise and vibration, thereby temporarily altering in-river conditions. Underwater noise exceeding certain thresholds (measured in terms of intensity and duration of exposure) can affect fishes in a number of ways, including physiological stress, temporary and permanent hearing loss, tissue damage (auditory and non-auditory), and direct mortality (Popper & Hastings 2009). High levels of underwater noise, such as that generated by impact pile driving, are known to cause injury and death to fishes.

Sublethal effects of elevated noise include damage to hearing organs that may temporarily affect swimming ability or hearing sensitivity, which may reduce the ability of fishes to detect predators and prey. Non-injurious levels of underwater noise may also cause behavioral effects (*e.g.*, startle or avoidance responses) that can disrupt or alter normal activities or expose individuals to increased predation risk. It is difficult to determine whether noise levels that trigger behavioral effects that could result in harm or harassment will occur, or to what extent. Adult salmonids generally avoid areas of construction activity, and therefore, are not expected to be adversely affected by construction noise because of their ability to readily avoid or migrate past the primary sources of underwater noise by utilizing deeper areas of the channel.

Prior to construction of the notch connection, pile driving may be required to install temporary steel sheet piles to isolate the construction area. Vibratory and/or impact pile driving may be necessary if other methods (*e.g.*, inflatable bladders) are determined to be infeasible or ineffective. If possible, piles will be installed using a vibratory hammer to reduce acoustic effects underwater to avoid exceeding the sound thresholds for salmon. However, there are large cobbles present at the site, so pile driving with an impact hammer may be necessary. For the purposes of analyzing the underwater acoustic impacts of the proposed action, we assume the worst-case scenario, which would consist of installing sheet piles with an impact hammer.

Measurements of sound pressure levels of in-water impact pile driving of 24-inch sheet piles for the Napa River Flood Control Project were used as a proxy for the acoustic analysis of this Proposed Action (Buehler *et al.* 2015). Actual project conditions may use 30-inch sheet piles. Based on an estimated 2400 strikes per day using the lowest typical sound pressure levels measured throughout a day, the peak and accumulated sound pressures are anticipated to be 188 decibels (dB) and 200.8 dB, respectively. These levels are below the threshold (using NMFS approved criteria) for injury to fishes from pile driving activities for peak sound pressure (206 dB peak), but above the cumulative SEL for fishes less than 2 grams (183 dB accumulated) and greater than 2 grams (187 dB accumulated). At these levels, the peak sound pressures threshold will be exceeded at 1m or closer to the source of impact. Cumulative sound pressures are expected to be exceeded from 136m or closer to the source (for fishes < 2g) and 83m or closer to the source (for fishes ≥ 2g). Single impact criteria will only be exceeded for fishes 1m or closer to the source of sound impact, but cumulative thresholds will be exceeded for any fishes 83-136m upstream or downstream of the construction area.

Using the highest typical sound pressure levels measured throughout a day, the peak and accumulated sound pressures are anticipated to be 195 dB (peak) and 203.8 dB (accumulated). These levels are below the threshold (using NMFS approved criteria) for injury to fishes from pile driving activities for peak sound pressure (206 dB peak), but above the cumulative SEL for fishes less than 2 grams (183 dB accumulated) and greater than 2 grams (187 dB accumulated). At these levels, the peak sound pressures threshold will be exceeded at 2m or closer to the source of impact. Cumulative sound pressures are expected to be exceeded from 1000m or closer to the source (for fishes < 2g) and 612 m or closer to the source (for fishes ≥ 2g). Single impact criteria will only be exceeded for fishes 2m or closer to the source of sound impact, but cumulative thresholds will be exceeded for any fishes 612-1000m upstream or downstream of the construction area.

To avoid and minimize acoustic effects to fishes, pile-driving activities shall only occur during daylight hours followed by non-work periods of at least eight hours at night to allow quiet migration conditions for anadromous fishes. This will allow substantial periods of noise refugia during the evening and at night when migration is most likely to occur. If impact driving is determined to be necessary, SBFCA will require the contractor to implement conservation measures to minimize the exposure of listed fish species to potentially harmful levels of underwater noise (see Section 1.3.3 *Avoidance and Minimization Measures*).

Given the intermittent nature of pile-driving activities and restriction of these activities to daylight hours, any exposures of adult fishes to pile driving noise or disruptions in migration behavior are expected to be brief. The most likely response of adult salmonids to pile driving activities would be temporary avoidance of the area. Adult green sturgeon are not expected to be present in the area during the construction window. Juveniles that are rearing or temporarily holding in the vicinity of the construction site would be at a higher risk of injury or mortality from exposure to peak or cumulative levels of pile driving noise (if impact pile driving is used) or behavioral effects that could increase their risk of predation. Juvenile fishes that migrate downstream in response to instream construction activities may endure short-term stress from being forced to migrate away from their rearing area and needing to locate a new rearing area downstream.

The duration of fish avoidance of these areas following the cessation of pile driving is unknown, but a rapid return to normal recruitment, distribution and behavior is anticipated. The temporary displacement of juvenile fishes and the increased risk of predation that they may face could affect the survival chances of individuals. Based on the size of the area that will likely be affected, the short duration of pile driving (4 days or less), and because the number of CV spring-run Chinook salmon, CCV steelhead, and green sturgeon expected to be displaced is small. However, injury or death is expected to a occur to a small proportion of each species due to displacement, reduced feeding, increased exposure to predation, ear damage, or swim bladder rupture as a result of underwater noise.

2.5.1.3 Increased Turbidity and Suspended Sediment

As a part of constructing the permanent notch connection, it is anticipated that grading within the Feather River would be needed. The intent of that grading would be to tie grades at the interior of the OWA with the grades of the Feather River. Activities related to grading and the construction of the notch connection will disturb the riverbank, resulting in temporary increases in turbidity and suspended sediments in the Action Area. Silt and sand within the channels of OWA D-Unit will also be disturbed in the action area during clearing, grubbing, and grading of the perimeter berm, excavation of interior channels and canals, and recreation access. However, these activities will be limited to the dry season (April 15- November 15) when there is no water flow in the OWA D-Unit. Channel excavation and canal grading is not directly connected to the Feather River and is therefore not considered as work within the Feather River channel. These activities will be short-term, localized, and minor; therefore, they are not expected to adversely affect water quality for fishes. Excavation activities will be subject to site-specific erosion and sediment control measures in accordance with a SWPPP.

Since much of the construction and grading will occur within the dry interior of OWA D-Unit, turbidity plumes are only expected to result from the opening of the notch connection and affect a portion of the Feather River channel, extend up to 1,000 feet downstream of the notch connection site. Turbidity increases could directly affect listed fish species that are migrating or holding in the river within or adjacent to the proposed construction footprint of the notch connection. Grading and installation of a cofferdam along the Feather River is expected to result in increases in turbidity and suspended sediment in the river through direct disturbance of sediments in an actively flowing portion of the river. Any increase in turbidity associated with instream work is likely to be brief and occur only in the vicinity of the site, attenuating downstream as suspended sediment settles out of the water column.

The short-term increases in turbidity and suspended sediment levels associated with construction may negatively impact fish populations temporarily through reduced availability of food, reduced feeding efficiency, and exposure to sediment released into the water column. Fish responses to increased turbidity and suspended sediment can range from behavioral changes (*e.g.*, alarm reactions, abandonment of cover which could lead to predation, and avoidance) to sublethal effects (*e.g.*, reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe & Jensen 1996). Temporary spikes in suspended sediment may result in behavioral avoidance of the site by fishes; several studies have documented active avoidance of turbid areas by juvenile and adult salmonids (Bisson & Bilby 1982, Lloyd *et al.* 1987, Servizi & Martens 1992, Sigler *et al.* 1984). Individual salmonids that encounter increased turbidity or sediment concentrations will likely move away from affected areas into suitable surrounding habitat. This is not typically true for green sturgeon.

High turbidity and suspended sediment levels can lead to reduced growth, survival, and reproductive success through a number of potential mechanisms such as reduced foraging ability, impaired disease resistance, and interference with cues necessary for orientation in homing and migration (Lloyd *et al.* 1987). Laboratory studies have demonstrated that chronic or prolonged exposure to high turbidity and suspended sediment levels can lead to reduced growth rates in juvenile salmonids. For example, Sigler *et al.* (1984) found that juvenile Coho salmon and steelhead trout exhibited reduced growth rates and higher emigration rates in turbid water (25–50 NTU) compared to clear water. Reduced growth rates in salmonids in turbid water have generally been attributed to their reliance on sight to effectively feed (Waters 1993). Green sturgeon may be affected in similar ways although they are presumably less sensitive to elevated turbidity because of their use of olfactory cues as opposed to vision to locate prey (NMFS 2008).

Restricting grading and cofferdam installation for the notch connection from June 15 to October 31 is expected to avoid the peak migration periods of spring-run Chinook salmon, steelhead, and green sturgeon. However, adult and juvenile steelhead may be present in the action area during the in-water work period, and spring-run Chinook salmon adults and juveniles may be present through June. Additionally, SBFCA or its contractor proposes to implement turbidity monitoring in the Feather River during active in-water work to ensure compliance with the CVRWQCB's turbidity objectives (see Section 1.3.3 *Avoidance and Minimization Measures*). Therefore, the impacts of increased turbidity are considered temporary and are not expected to reach a level that will acutely affect aquatic organisms.

2.5.1.4 Contaminants & Hazardous Materials

Operation of construction equipment in or adjacent to the river presents the risk of a spill of hazardous materials into the river (*e.g.*, construction equipment leaking fluids). Toxic substances used at construction sites, including gasoline, lubricants, and other petroleum-based products could enter the waterway and have deleterious effects on listed salmonids, green sturgeon, and their prey. Potential effects of contaminants on fish include direct injury and mortality (*e.g.*, damage to gill tissue causing asphyxiation) or delayed effects on growth and survival (*e.g.*, increased stress or reduced feeding), depending on the type of contaminant and exposure concentrations. Petroleum products also tend to form oily films on the water surface that can reduce DO levels available to aquatic organisms.

The risk of such effects will be highest during in-water construction activities because of the proximity of construction equipment to the Feather River. However, this risk will be minimized by the implementation of a SPCCP, which is intended to prevent any discharge of oil into navigable water or adjoining shorelines. Before construction activities begin, SBFCA or its contractor will develop and implement an SPCCP to minimize the potential for spills of hazardous, toxic, or petroleum substances during construction and operation activities. NMFS expects that implementation of the BMPs described in the SWPPP, will ensure that the potential for the release and exposure of construction-related contaminants will be avoided and/or minimized. Implementation of the SPCCP and BMPs are expected to reduce the likelihood or severity of fuel spills or toxic compound releases to a point where they are not expected to cause adverse effects to any life stages of spring-run Chinook salmon, CCV steelhead, and green sturgeon.

2.5.1.5 Mercury

The inundation of floodplains play an important role in the methylation, mobilization, and transport of mercury. The construction of the Proposed Project, particularly work within the D-Unit involving the grading and modification of the interior channels has the potential to expose clay and silt sized particles which may have elevated mercury levels. These finer-sized sediments with elevated mercury could then be transported into the wetted channel of the Feather River during high flow events. A fraction of the mercury may then methylate and become toxic to fishes and other biota in the Feather River. Methylmercury has a range of toxic effects to fish including behavioral, neurochemical, hormonal, and reproductive changes. In one study of Atlantic salmon (*Salmo salar*), methylmercury caused altered behavior and pathological damage (Berntssen *et al.* 2003).

Pit testing was conducted at four locations in the OWA D-Unit. Mercury is not a concern at the rock gabion inflow weir because mercury was below the laboratory detection limits. No further testing in this area is necessary. SBFCA proposes to test for mercury at the outflow weir prior to construction due to the in-water work that will occur.

Additionally, a geomorphic technical memorandum analyzing the overall hydraulic changes was prepared to determine if the project would have potential to mobilize additional sediment/mercury and send it downstream. Given existing conditions, water currently inundates and washes out the project area. No new areas of dredge tailings will be inundated as a result of the project. The Feather River system has a large amount of historical dredge tailings and the project area represents a small percentage of the total. A percentage of the existing dredge tailings in the project area have been excavated and removed as part of the construction of Oroville Dam. Reducing stage and velocities along the reach between the inflow and outflow weirs will decrease the potential for mercury loadings from the dredge tailings in this reach, particularly where there are unvegetated dredge tailings near the top of steep slopes. Given these conditions, impacts to all life stages of CV spring-run Chinook salmon, CCV steelhead, and sDPS North American green sturgeon from increased mercury levels are not expected to occur.

2.5.2 Effects of the Proposed Action to Critical Habitat and PBFs

Construction is expected to have short-term effects on habitat quantity and quality, including effects on the PBFs of designated critical habitat of CV spring-run Chinook salmon, CCV steelhead, and southern DPS green sturgeon. The PBFs for CV spring-run Chinook salmon and CCV steelhead in the action area that may be impacted are 1) freshwater rearing habitat, and 2) freshwater migration corridors; no spawning habitat is present. The PBFs for southern DPS green sturgeon in the action area that may be impacted are 1) freshwater migration corridors; no spawning habitat is present. There will be temporal impacts to vegetation within freshwater migration corridors. Impacts to the PBFs for sDPS green sturgeon of food resources, substrate, water quality, and sediment quality are not expected.

Construction of the hydraulic and recreation improvements, including the inflow and outflow weirs, notch connection, fish barrier berm, and low flow outlet improvements, intersect partially with areas characterized as riparian forest, riparian scrub-shrub, and open water (*e.g.*, ponds, canal, and river channel). Disturbance and removal of some existing riparian trees and shrubs will occur in localized areas resulting in reduced cover, shade, and contribution to food supply. Temporary habitat loss is expected to result in adverse effects to fishes, such as increased localized temperatures, predation mortality due to loss of cover, and a reduction in food supply that could lead to reduced growth rates and contribute to lower survival. These losses are expected to be short-term (up to five years) given the proposed replanting schedule.

2.5.2.1 Impacts to Habitat

Within the interior of the OWA and below the OHWM of the Feather River, there will be impacts to habitat. Short-term vegetation losses (< 5 years) are given in Table 5 and include impacts to riparian forest vegetation, riparian scrub-shrub, and aquatic habitat (*e.g.*, open water, ponds, and canals). Estimated temporary impacts on riparian vegetation and open water within the designated construction limits represent the maximum extent of clearing and other construction-related disturbances; these effects may be reduced depending on equipment access needs. Interior channel grading and construction of the fish barrier berm may result in additional losses of riparian vegetation depending on equipment access needs, final grading plans, and alignment of the berm.

Table 5. Summary of Habitat Impacts (acres) for the Proposed Action.

	HABITAT TYPE		
Description of Habitat Impacts	**Riparian Forest (acres)**	**Riparian Scrub-scrub (acres)**	**Aquatic Habitat (acres)**
Habitat Loss in OWA Interior	1.5	0.1	0.3
Habitat Loss Below the OHWM of the Feather River	0.1	0.1	0.02
Temporary Habitat Impacts	12.3	1.1	1.3

Riparian habitat, particularly shaded riverine aquatic (SRA) cover, is important for rearing and out-migrating juvenile salmon because it provides overhead and instream cover from predation and enhances food production. Shade from the overhanging vegetation helps to cool in-river water temperatures and provides insects for fish to forage. Terrestrial insects that live on riparian vegetation fall into the river and provide an important food source for fishes. Riparian trees and shrubs will eventually end up in the river channel as floods erode the bank or sweep them from the floodplain. Once in the river channel, the stems, trunks, and branches become very important structural habitat components for aquatic life, including fishes. Many of the aquatic invertebrates that are primary food sources for juvenile salmon and steelhead live on woody debris. Large wood affects the hydraulics of flows around it, resulting in a more complex channel geomorphology and increasing the storage of spawning gravels. The loss of riparian vegetation will reduce food production and feeding rates for juveniles, as well as increase rates of predation.

2.5.2.2 Vegetation Restoration and Management

To compensate for impacts to critical habitat, vegetation management and restoration components of the proposed action will be conducted concurrently with construction of the hydraulic improvements during the first year of construction season and will be completed during the second year. These components include the removal of approximately 500 acres of water primrose and 200 acres of other invasive plant species and the planting of approximately 150 acres of new riparian woodland and wetland plantings along the interior channels and floodplain within the OWA. While invasive species removal, interior channel grading, and planting of riparian and wetland vegetation would temporarily disturb existing habitat, the overall effect of these actions would provide a substantial increase in the ecological values (*e.g.*, total rearing area, habitat complexity, cover) of the OWA for spring-run Chinook salmon, steelhead, green sturgeon, and other native fish and wildlife species in the Action Area.

The Proposed Project is expected to have a positive effect on the salmonid critical habitat PBF of freshwater rearing habitat. Overbank flows combined with riparian vegetation are key to reestablishing in-channel complexity. In addition, restored channel complexity will enhance in-stream hyporheic exchange through bedforms, buffer temperature fluctuations, and provide temperature refugia for salmonids, significantly improving out-migrant survival during spring heat waves.

Ultimately, the Proposed Project is expected to have a positive effect on the salmonid and green sturgeon critical habitat PBF of freshwater migration corridors, as it has been designed to address existing fish stranding areas with strategic grading of the interior channels of the OWA. The essential features of freshwater rearing and migration 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 these habitats are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults.

2.5.2.3 Restoring Floodplain Connectivity and Inundation

The creation and enhancement of frequently inundated floodplain to provide high quality juvenile salmonid rearing habitat is one of the primary goals of the project and is expected to have measureable benefits to the PBFs of freshwater rearing for salmonids and green sturgeon. The suitability of aquatic habitat for juveniles depends on the presence of nearshore areas with shallow water, instream woody material, and aquatic and riparian vegetation. The OWA FSRP will improve functional value of existing flow regime to listed fish populations by restoring river-floodplain connectivity. The lack of inundated floodplain habitat for rearing salmonids is a major limiting factor in the Feather River corridor.

In addition to restoring connectivity, the new connection will also enhance floodplain/off-channel habitat values in the OWA by increasing the area and duration of floodplain inundation over a broad range of flows. Hydraulic modeling indicates that the new connection would create approximately 150 acres, 400 acres, and 875 acres of shallow floodplain habitat during the historical 2-year, 3-year, and 6-year flow events, respectively. Larger events (100-year and larger) are not expected to change the extent of inundation because water fully inundates the action area during such events under existing conditions; however, during all events, the proposed action is expected to improve floodplain rearing opportunities because of extended periods of floodplain inundation following recession of floodwaters. The proposed action would increase the duration of inundation of ≥ 25 acres from 0 days under existing conditions to 24 days for a typical average water year. During a typical wet year, the proposed action would increase the duration of inundation of ≥ 25 acres from 14 days under existing conditions to 90 days. A threshold of 25 acres was used because that is the point where the interior channel banks begin to overflow and inundate the surrounding floodplain. During larger events such as occurred in 1997 and 2006, the duration of inundation of 25 acres or more is expected to increase from 1-2 weeks to 2-4 months.

Increasing the area and frequency of floodplain inundation will provide juvenile salmonids and other fishes with valuable feeding and resting habitat, concealment from predators, and refuge during high flows (Jeffres *et al.* 2008). Creation of floodplains, side channels, and other off-channel areas that increase habitat complexity and inundate more frequently will function as high quality juvenile rearing habitat. Increased residence time of water in floodplains allows for the production of macroinvertebrates that juvenile salmonids feed on, which will lead to increased growth, larger size at outmigration, and survival to the ocean.

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 proposed action 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 climate change section of the environmental baseline (Section 2.4.2.10).

2.6.1 Water Diversions and Agricultural Practices

Non-Federal actions that may affect the action area include water diversions for irrigated agriculture, ongoing agricultural activities, municipal and industrial use, and managed wetlands found along the Feather River action area. Agricultural practices in and upstream of the Feather River may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in stream channels flowing into the Feather River. Water withdrawals and diversions may result in entrainment of fishes into unscreened or improperly screened diversions, and may result in depleted river flows that are necessary for migration, spawning, rearing, sediment flushing from spawning gravels, gravel recruitment, and transport of large woody debris. Depending on the size, location, and season of operation, these unscreened agricultural diversions entrain and kill many life stages of aquatic species, including juvenile salmonids and green sturgeon. For example, as of 1997, 98.5 percent of the 3,356 diversions included in a CV database were either unscreened or screened insufficiently to prevent fish entrainment (Herren & Kawasaki 2001).

Stormwater and irrigation discharges related to agricultural activities contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (Dubrovsky *et al.* 1998, 2000; Daughton 2003). Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds.

2.6.2 Aquaculture and Fish Hatcheries

More than 32-million fall-run Chinook salmon, 2-million spring-run Chinook salmon, 1-million late fall-run Chinook salmon, 0.25-million winter-run Chinook salmon, and 2-million steelhead are released annually from six hatcheries producing anadromous salmonids in the CV. All of these facilities are currently operated to mitigate for natural habitats that have already been permanently lost as a result of dam construction. The loss of historical habitat and spawning grounds upstream of dams results in dramatic reductions in natural population abundance, which is mitigated for through the operation of hatcheries. Salmonid hatcheries can, however, have additional negative effects on ESA-listed salmonid populations.

The high level of hatchery production in the CV can result in high harvest-to-escapements ratios for natural stocks. California salmon fishing regulations are set according to the combined abundance of hatchery and natural stocks, which can lead to over-exploitation and reduction in the abundance of wild populations that are indistinguishable and exist in the same system as hatchery populations. Releasing large numbers of hatchery fish can also pose a threat to wild Chinook salmon and steelhead stocks through the spread of disease, genetic impacts, competition for food and other resources, predation of hatchery fish on wild fish, and increased fishing pressure on wild stocks as a result of hatchery production.

Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler *et al.* 1996). Ocean events cannot be predicted with a high degree of certainty at this time. Until good predictive models are developed, there will be years when hatchery production may be in excess of the marine carrying capacity, placing depressed natural fish at a disadvantage by directly inhibiting their opportunity to recover (NPCC 2003).

2.6.3 Increased Urbanization

Future urban and/or rural residential development may adversely affect water quality, riparian function, and aquatic productivity. Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, 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 that 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 also is expected to result in increased recreational activities in the region. Recreational activities can potentially disturb the current riparian vegetation and/or listed fish in the active channel. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspension of contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

2.6.4 Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Feather River watershed. For example, most of the levees have roads on their crown, which are maintained either by the county, reclamation district, owner, or by the state. Landowners may utilize roads at the top of the levees to access part of their agricultural land. The effects of such actions result in continued fragmentation of existing high-quality habitat, and conversion of complex nearshore aquatic to simplified habitats that affect salmonids in ways similar to the adverse effects associated with this project.

Most of these actions would require Federal permits, and would undergo individual or programmatic Section 7 consultation. No known specific and reasonably certain future state or private activities are expected to occur within the Action Area, other than those ongoing activities already discussed in the existing conditions.

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 proposed action. 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 proposed action 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 Status of the Species, Environmental Baseline, and Effects of the Action to Listed Species

The action area currently has a returning population of CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon. As described earlier (in *Status of the Species* Section 2.2), populations of CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon have experienced significant declines in abundance and available habitat in California's Central Valley relative to historical conditions. The current status of listed salmonids within the action area, based upon their risk of extinction, has not significantly improved since the species were listed (Good *et al*. 2005; Williams *et al.* 2016). This severe decline in populations over many years, and in consideration of the degraded environmental baseline, demonstrates the need for actions which will assist in the recovery of all of the ESA-listed species in the action area, and that if measures are not taken to reverse these trends, the continued existence of CV spring-run Chinook salmon, CCV steelhead, and the sDPS of North American green sturgeon will continue to be at risk. The current extinction risk for each species was described in section 2.2 above, concluding an increase a slight decrease for CV spring-run Chinook salmon 2011 to 2014, but with concerns for 2015 to 2018 due to effects of severe drought, a continued high risk of extinction for CCV steelhead, and a moderate risk of extinction for the sDPS of North American green sturgeon.

As described in the effects section (Section 2.5), the Proposed Action is likely to affect various life stages of CV spring-run Chinook, CCV steelhead, and the sDPS of green sturgeon including rearing and emigrating juveniles, and migrating adults.

Construction Effects

During construction, juvenile CV spring-run Chinook, CCV steelhead, and juvenile sDPS green sturgeon are the life stages most likely to be impacted. Stranding, injury, or death to individual fishes is likely to result from the installation of the cofferdam surrounding the notch construction. A small proportion of the Feather River populations of these species is expected to be adversely affected.

Pile driving associated with cofferdam installation and grading of a new channel that will comprise the notch are likely to result in acoustic impacts and increased turbidity. These construction effects may result in injury or death to salmonids and green sturgeon due to physiological damage from sound impacts, avoidance activity, gill fouling, reduced foraging capability, and increased predation related to displacement of individuals away from the shoreline or at the margins or turbidity plumes.

Pollution from hazardous materials and mercury methylation may occur as a result of the Proposed Action, however, BMPs and proper implementation of avoidance and minimization will aid in minimizing impacts to listed fish species in the Feather River. These construction type actions will occur during summer and early fall months, when the abundance of individual salmon and steelhead is low and is expected to result in correspondingly low levels of injury or death.

For juvenile and outmigrating salmonids and green sturgeon, the proposed action will result in some short- and long-term adverse effects to individuals that are exposed to the project features along the Feather River and in the channels and ponds of the OWA D-Unit. For juvenile rearing salmonids and green sturgeon, shoreline habitat conditions are temporarily worsened by the removal of invasive and native vegetation compared to the environmental baseline due to the loss of shade, cover, and food inputs.

Effects to migrating steelhead, migrating Chinook, and steelhead residents (outmigrating post-spawning adults) are not considered adverse because adult salmonids are unlikely to use the nearshore habitat that will be affected by this project, preferring deeper water instead. Furthermore, the project is not anticipated to cause an increase in predation or install any structural features that might impede adult migration.

2.7.2 Summary of the Status of Critical Habitat, Environmental Baseline, and the Effects of the Action to Critical Habitat

The status of the species and critical habitat and environmental baseline sections (2.2 and 2.4) are described for each species ESU/DPS-wide, and in the Feather River, where the Proposed Action is to occur. Past and present impacts within the Feather River basin have caused significant loss of habitat. Populations have declined drastically over the last century, and some subpopulations have been extirpated. The construction of dams has limited access to a large and significant portion of historical spawning and rearing. Dam operations have changed downstream flow patterns, effecting stream dynamics (*e.g.,* geomorphology, habitat configuration, *etc*.), and affected available habitat through changes in water temperature characteristics, limiting gravel recruitment to available spawning reaches, and limiting the introduction of LWM which contributes to habitat diversity. CV spring-run Chinook and CCV steelhead continue to be threatened by unscreened or inadequately screened water diversions, excessively high water temperatures, and predation by non-native species. Section 2.2.4 discusses the vulnerability of critical habitat to climate change projections in the California Central Valley. In light of the predicted impacts of global warming, it has been hypothesized that summer temperatures and flow levels will become unsuitable to support salmonid survival in many parts of the Central Valley. Cumulative effects (Section 2.6) that may affect the Action Area include water diversions and agricultural practices, aquaculture and fish hatcheries, increased urbanization, and rock revetment and levee repair projects. The Proposed Action contains restoration goals of promoting natural river processes, increasing the availability and quality of side channel habitat, reducing stranding and isolation, and increasing instream cover. These actions are consistent with the NMFS Recovery Plan for CCV spring-run Chinook and CCV steelhead, and are intended to aid in their long-term recovery and survival (NMFS 2014).

Freshwater rearing habitat PBFs for listed salmonids and the freshwater migratory corridors for green sturgeon are likely to be adversely affected through a variety of physical and biological mechanisms during construction including the potential spill of contaminants, mercury methylation and mobilization, and underwater noise. The migration corridor PBF for salmonids also is likely to be adversely effected in the course of the proposed construction operations due to increased turbidity and sedimentation. Although the OWA will continue to provide permanent habitats (e.g., isolated ponds) that support non-native warm water fish species (e.g., largemouth bass, sunfish, catfish), improved connectivity of the interior ponds and channels, construction of a fish barrier berm, and establishment of a permanent hydraulic connection between the OWA and Feather River is expected to minimize potential interactions (predation or competition) between these species and native fish species during floodplain inundation events.

The beneficial effects of the proposed action expected includes enhancement of critical habitat PBFs contained in the Action Area for salmonids and green sturgeon. Temporal impacts are expected to be offset by permanent increases in floodplain habitat, riparian habitat, and river-floodplain connectivity associated with vegetation management and restoration actions, interior channel improvements, and reconnection of the OWA to the Feather River. Conditions are expected to improve quickly (within five years) with the planting of an additional 150 acres of new woody riparian vegetation along the interior channels. Once the native vegetation has become established, conditions will be improved significantly over baseline. With the proposed invasive plant species management, riparian restoration, and improved river-floodplain connectivity, impacts to the critical habitat of CV spring-run Chinook, CCV steelhead, and sDPS green sturgeon are expected to be localized, minor, and short-term.

The purpose of the proposed Federal action is to reduce flood stage and improve habitat within the OWA D-Unit. The construction of the proposed new inflow weir and notch connection will restore connectivity of the Feather River with the OWA D-Unit and will substantially improve the duration of floodplain inundation over a broad range of flows. Improvements will provide new fish rearing habitat, reduce stranding, and improve passage opportunities by connecting isolated ponds to the existing interior channel system and establishing a permanent hydraulic connection between the OWA D-Unit and Feather River to convey floodwaters back to the main channel. Reconnection of the river to its historic floodplain and creation of new seasonal floodplain/off-channel habitat is expected to reduce the risk of fish stranding in the OWA D-Unit following major flood events and create annual opportunities for fish to volitionally access the OWA during key salmonid rearing and migration periods. These benefits will be further enhanced by the construction of the fish barrier berm, and removal of invasive aquatic plants, which will expand the amount of usable (open water) habitat, facilitate fish movement back to the river following major flood events, and prevent stranding in the Pit 2 pond and other isolated ponds and channels.

The combination of improvements is expected to have long-term beneficial effects on salmonids and green sturgeon and their designated critical habitat. The potential ecological benefits include improved growth and survival associated with floodplain/off-channel rearing. Implementation of the Proposed Action will reduce the stranding risk for green sturgeon caused by the current configuration of the channels within the OWA D-Unit.

2.7.3 Summary of Effects to ESU/DPS

Salmonids

Despite the impaired genetic status of the Feather River populations of spring-run Chinook and steelhead, and the substantial reduction in habitat availability and suitability since the construction of the Oroville Facilities, the value of the lower Feather River basin as a migratory corridor, its location as the southern-most extant population of spring-run Chinook salmon, and its suitability as spawning and rearing habitat make it an important node of habitat for the survival and recovery of the species.

Restoration goals outlined in the Proposed Action are consistent with specific recommended recovery actions for the Feather River outlined in the NMFS CV Salmonid Recovery Plan (NMFS 2014). Recovery actions for the Feather River include implementing and maintaining projects to promote natural river processes, increasing the availability and quality of side channel habitat, reducing stranding and isolation, and increasing instream cover (NMFS 2014). VSP parameters of spatial structure, diversity, abundance, and productivity are not expected to be appreciably reduced during or after completion of construction and subsequent restoration. In contrast, implementation of the Proposed Action is expected to improve VSP parameters through enhancements to critical habitat quality, reduction in stranding potential, and improved passage opportunities, which will improve growth, survival, and production in the Feather River.

Green Sturgeon

Recent population estimates for the southern DPS of North American green sturgeon indicate that there are few fish relative to historic conditions, and that loss of habitat has affected population size and distribution. However, the southern DPS of North American green sturgeon remain widely distributed along the Pacific coast from California to Washington, and recent findings of fish in the Feather and the Yuba River indicate that their distribution in the Central Valley may be broader than previously thought. This suggests that the DPS probably meets several viable species population criteria for distribution and diversity, and indicates that the Southern DPS of North American green sturgeon faces a low to moderate risk of extinction. The Proposed Project is not expected to impede the survival or recovery of sDPS green sturgeon, and may improve survival and recovery of the sDPS green sturgeon by restoring natural ecosystem process to the lower Feather River and within the OWA D-Unit.

ESU/DPS

The Feather River is in the northern Sierra Nevada diversity group region of the Central Valley. One of the important specific stressors to this diversity group within the ESU and DPS is Oroville Dam blocking access to habitat historically used by Feather River spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. One of the important recovery actions for the Feather River watershed is to implement projects that promote natural processes (*e.g.*, floodplain and riparian restoration) that focus on retaining, restoring, and creating active floodplain and riparian corridors.

It is important to note that delays of benefits to listed species and critical habitat increases risk to survival and recovery. NMFS expects that any adverse effects of the Proposed Action will be outweighed by the long-term benefits to species. These benefits would be derived through enhancements to habitat quality, reduction in stranding potential, and improved passage opportunities in the OWA. More restoration efforts are needed to improve likelihood survival and recovery of the species. Overall, considering the status of the species, the environmental baseline, and cumulative effects, NMFS expects that any adverse effects of the proposed action are not the type or magnitude that are expected to appreciably reduce the likelihood of both the survival and recovery of the affected listed species in the action area, or at the ESU/DPS level. Nor are any adverse effects of the proposed action to critical habitat expected to appreciably reduce the value of designated critical habitat for the conservation of the species.

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 proposed action, any effects of interrelated and interdependent activities, and cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon or destroy adversely modify their designated critical habitat.

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 the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows: incidental take of juvenile and adult CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and juvenile and adult sDPS of green sturgeon as a result of the Oroville Wildlife Area Flood Stage Reduction Project. NMFS anticipates that juvenile and adult CV spring-run Chinook salmon, juvenile and adult CCV steelhead, and juvenile and adult sDPS of green sturgeon will be stressed, captured, injured, or killed as a result of project implementation due to their presence in the Action Area during the scheduled work period each year.

Specifically, incidental take is expected to occur during (1) cofferdam installation and (2) isolation of the notch reconnection area via dewatering at the southwestern end of the OWA. Incidental take is expected to occur in the form of stress, capture, injury, or death. NMFS cannot precisely quantify and track the amount or number of individuals per species that are expected to be taken incidentally as a result of the proposed project. This is due to the variability and uncertainty associated with the response of listed species to the effects of the proposed action, the varying population size of each species, annual variations in the timing of migration, individual habitat use within the action area, and difficulty in observing injured or dead fishes.

However, it is possible to estimate the extent of incidental take by designating as ecological surrogates, those elements of the project that are expected to result in incidental take, that are more predictable and/or measurable, with the ability to monitor those surrogates to determine the extent that incidental take that is occurring. The most appropriate threshold for incidental take are ecological surrogates of temporary habitat disturbance during the construction of the notch reconnection (including use of cofferdam to dewater the area), interior channel grading, and riparian habitat removal (*i.e.*, riparian forest, scrub shrub, and SRA cover). The amount of unintentional injury and mortality attributable to acoustic impacts is based on an ecological surrogate of area expected to be impacted under various sound pressure scenarios. The amount of unintentional injury and mortality attributable to fish relocation varies widely depending on the method used, ambient conditions, and the experience of the field crew. The expected proportion of listed juveniles isolated in the cofferdam area is low. Since fish relocation activities will be conducted by qualified fisheries biologists following NMFS guidelines, direct effects to and mortality of juvenile Chinook salmon, steelhead, and green sturgeon during relocation activities is expected to be minimal (less than 10 percent).

The behavioral modifications or fish responses that result from the habitat disturbance are described below. NMFS anticipates incidental take will be limited to the following forms of juvenile and adult CV spring-run Chinook salmon, CCV steelhead, and sDPS of North American green sturgeon:

1. Injury or death during installation of sheet piles to form the cofferdam at the notch connection, resulting in acoustic disturbances that extend to the opposite bank of the Feather River and up to 1,000m upstream and downstream of the site. Increases in noise are reasonably certain to result in injury or death resulting from physiological impacts (*i.e.*, to the ears or swim bladders of fishes)

2. Injury or death during sheet pile installation beyond 1,000m upstream and downstream of the notch connection site through modification or degradation of the PBFs for rearing and migration. Fishes may not enter the area impacted by sound resulting in temporary displacement of individuals, a temporary barrier to passage, reduced feeding, and increased predation.

3. Injury or death resulting from habitat-related disturbances during notch construction activities, resulting in turbidity increases that extends up to 100 feet from the bank and 1,000 feet downstream. Increases in turbidity are reasonably certain to result in harm to the species through modification or degradation of the PBFs for rearing and migration that will result physiological impacts (*i.e.*, to the gills of fishes), temporary displacement of individuals, reduced feeding, and increased predation.

4. Injury or death during dewatering of the area between cofferdam and the berm (< 0.4 acre), including fish capture/relocation efforts, which may utilize herding, netting, seining, or electrofishing to capture/relocate fishes.

5. Harm from habitat-related disturbances from the removal of 0.1 acre of riparian forest, 0.1 acre of riparian scrub-shrub, and 0.02 acre of open water (nearshore aquatic habitat)

within the OHWM of the Feather River in the permanent footprints of the notch connection and recreational access areas. Temporary effects within the OHWM of the Feather River include approximately 0.3 acre of riparian forest, 1.2 acres of riparian scrub-shrub, and 0.3 acre of open water. Removal of vegetation is reasonably certain to result in harm to the species through modification or degradation of the PBFs for rearing and migration that will result in temporary displacement of individuals, loss of cover, increased predation, and reduced growth due to decreased food inputs.

6. Harm or injury from habitat-related disturbances from the removal approximately 1.5 acres of riparian forest, 0.1 acre of riparian scrub-shrub, and 0.3 acre of aquatic habitat (ponds and canals) within the interior of the OWA. Potential temporary effects within the designated construction limits include approximately 12.3 acres of riparian forest, 1.1 acres of riparian scrub-shrub, and 1.3 acres of open water. Removal of vegetation is reasonably certain to result in harm to the species through modification or degradation of the PBFs for rearing and migration that will result in loss of cover, increased predation, and reduced growth due to decreased food inputs.

If any specific parameter of this ecological surrogate is exceeded, the anticipated incidental take levels described are also exceeded, triggering the need to reinitiate consultation.

2.9.2 Effect of the Take

In the opinion, 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 CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon or destruction or adverse modification of their 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).

1. Measures shall be taken by the Corps and the applicant to minimize acoustic impacts in the Action Area and their direct and indirect effects to listed species and their critical habitat.

2. Measures shall be taken by the Corps and the applicant to minimize sedimentation and turbidity plumes in the Action Area and their direct and indirect effects to listed species and their critical habitat.

3. Measures shall be taken by the Corps and the applicant to minimize impacts to riparian vegetation in the Action Area and its direct and indirect effects to critical habitat.

4. Measures shall be taken by the Corps and the applicant to ensure that contractors, construction workers, and all other parties involved with these projects implement the BMPs as detailed in the BA and this opinion.

5. Measures shall be taken by the Corps and the applicant to monitor and provide NMFS with a report associated with the proposed action.

2.9.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant must comply with them in order to implement the reasonable and prudent measures (50 CFR § 402.14). The Corps 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 proposed action would likely lapse.

1. The following terms and conditions implement reasonable and prudent measure 1:
    a. If feasible, the contractor will vibrate all piles to the maximum depth possible before using an impact hammer.
    b. During impact pile driving, the contractor will limit the number of strikes to the minimum necessary to complete the work.
    c. The smallest pile driver and minimum force necessary will be used to complete the work.
    d. During impact pile driving, a qualified fish biologist will monitor the area surrounding the construction site for fish exhibiting signs of distress.
    e. The fish biologist will contact NMFS and DFW immediately if any steelhead, Chinook salmon, or sturgeon are observed or found dead or injured during impact pile driving.
    f. No pile driving will occur at night.
2. The following terms and conditions implement reasonable and prudent measure 2:

    a. BMPs shall be implemented to prevent soil erosion and sediment incursion into the active channel of the Feather River. Straw bales, straw wattles and silt fences shall be installed at source sites for the project, as appropriate.

    b. Operation of heavy machinery in the active channel shall be minimized to avoid disturbance of substrates.

    c. Turbidity and settleable solids shall be monitored according to water quality permits. If acceptable limits are exceeded, work shall be suspended until acceptable measured levels are achieved.

    d. Disturbed areas adjacent to the active channel that are deemed unstable shall be vegetated with native plant species and/or mulched with certified weed-free hay upon project completion.

3. The following terms and conditions implement reasonable and prudent measure 3:

    a. Equipment used for the project shall be thoroughly cleaned off-site to remove any invasive plant material or invasive aquatic biota prior to use in the Action Area.

    b. Environmentally sensitive areas, sensitive plant species and wetland areas shall be avoided during project activities to the maximum extent practicable. High visibility fencing shall be placed around these areas to minimize disturbance.

    c. Soil and excavated material and/or fill material shall be stockpiled in existing clearings when possible.

4. The following terms and conditions implement reasonable and prudent measure 4:

    a. The Corps shall require that SBFCA provide a copy of this opinion to the Sutter Yard maintenance crew, making them responsible for implementing all requirements and obligations included in this document and for educating and informing all other contractors involved in the project as to the requirements of this opinion. A notification that the Sutter Yard maintenance crew have been supplied with this information shall be provided to the reporting address below.

5. The following terms and conditions implement reasonable and prudent measure 5:

    a. The Corps shall require SBFCA to monitor vegetation plantings and conduct post-project maintenance for 3 years. Maintenance activities include conducting weed control, operating irrigation systems throughout the irrigation period, maintaining irrigation systems, debris removal, and replacing dead or severely stressed plants. These activities would be limited to the dry season and areas above the wetted channel (or where there is no surface connection to the river) and therefore are not expected to have any direct or indirect effects on listed species or aquatic habitat.
    b. The Corps shall require that SBFCA submit to NMFS an annual report describing the incidental take resulting from the Proposed Project. This shall include any fishes captured and relocated during cofferdam/dewater activities. This report shall be filed not later than January 1st, covering the instream construction window from the previous year. The report should be submitted to the following address:

        Maria Rea
        California Central Valley Office
        National Marine Fisheries Service
        650 Capitol Mall, Suite 5-100
        Sacramento CA 95814
        Phone: (916) 930-3600
        FAX: (916) 930-3629

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 proposed action on listed species or critical habitat or regarding the development of information (50 CFR § 402.02).

1. The Corps and the applicant should minimize any potential take whenever possible, and implement practices that avoid or minimize negative impacts to salmon, steelhead, green sturgeon and their critical habitat.

2. The Corps and the applicant should support and promote aquatic and riparian habitat restoration within the Feather River and other watersheds, especially those with listed aquatic species. Practices that avoid or minimize negative impacts to listed species should be encouraged.

3. The Corps and the applicant 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 Recovery Actions in the NMFS Salmonid Recovery Plan (NMFS 2014).

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 Oroville Wildlife Area Flood Stage Reduction 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 opinion; (3) the agency action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in this opinion; or (4) a new species is listed or critical habitat designated that may be affected by the action.

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

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 the Corps and descriptions of EFH for Pacific Coast Salmon (PFMC 2014) contained in the Fishery Management Plans (FMP) developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH is designated under the Pacific Coast Salmon FMP, which includes the action area of the proposed action. EFH in the action area consists of adult migration habitat and juvenile rearing and migration habitat for the three Chinook salmon runs (spring-, fall-, and late fall-run Chinook salmon). Habitat Areas of Particular Concern (HAPCs) that may be either directly or indirectly adversely affected include (1) Complex Channels and Floodplain Habitats, and (2) Thermal Refugia. The other HAPCs for Pacific Coast Salmon, (3) Spawning Habitat, (4) Estuaries, and (5) Marine and Estuarine Submerged Aquatic Vegetation, are not present in the Action Area.

3.2 Adverse Effects on Essential Fish Habitat

Construction activities would result in increased sedimentation, turbidity, and the potential for contaminants to enter the waterway. Channel grading would result in adverse effects to EFH due to temporary losses of riparian habitat and disturbance of natural substrate. The net amount of aquatic habitat that will be lost is 0.32 acre with an additional 1.3 acres temporarily impacted. The net amount of riparian forest that will be lost is 1.6 with an additional 12.3 acres temporarily impacted. The net amount of riparian scrub-shrub that will be lost is 0.2 acre with an additional 1.1 acres temporarily impacted.

Consistent with the ESA portion of this document, which determined that aspects of the proposed action would result in impacts to listed fish species and critical habitat, we conclude that aspects of the proposed action would also adversely affect EFH for Chinook salmon. Effects to the HAPCs listed in Section 3.1 were described in detail in Section 2.5 and subsections. A list of temporary and permanent adverse effects to EFH HAPCs is included in this EFH consultation. We conclude that the following adverse effects on EFH designated for Pacific Coast Salmon are reasonably certain to occur (affected HAPCs are indicated by number, corresponding to the HAPCs listed above in Section 3.1):

<u>Sedimentation and Turbidity</u>

- ➢ Reduced habitat complexity (1)
- ➢ Degraded water quality (1, 2)

- Reduction in aquatic macroinvertebrate production (1)

Contaminants and Pollution-related Effects

- Degraded water quality (1, 2)
- Reduction in aquatic macroinvertebrate production (1)

Removal of Riparian Vegetation

- Reduced shade (2)
- Reduced supply of terrestrial food resources (1)
- Reduced supply of LWM (1)

3.3 Essential Fish Habitat Conservation Recommendations

The following conservation recommendations are necessary to avoid, mitigate, or offset the impact of the proposed action on EFH:

1. To protect HAPC #1 (Complex Channels and Floodplain Habitats), NMFS recommends that the Corps and the applicant adopt term and condition (T&C) 1(a, b, c, and d), 2(a, b, and c), and 4(a).

2. To protect HAPC #2 (Thermal Refugia), NMFS recommends that the Corps and the applicant adopt T&C 4(a).

Fully implementing the above listed EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, 550 acres of designated EFH for Pacific Coast Salmon.

3.4 Statutory Response Requirement

As required by section 305(b)(4)(B) of the MSA, the Corps and the applicant must provide a detailed response in writing to NMFS within 30 days after receiving an EFH Conservation Recommendation. Such a response must be provided at least 10 days prior to final approval of the action if the response is inconsistent with any of NMFS' EFH Conservation Recommendations unless NMFS and the Federal agency have agreed to use alternative time frames for the Federal agency response. The response must include a description of measures proposed by the agency for avoiding, minimizing, mitigating, or otherwise offsetting the impact of the activity on EFH. In the case of a response that is inconsistent with the Conservation Recommendations, the Federal agency must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the action and the measures needed to avoid, minimize, mitigate, or offset such effects (50 CFR 600.920(k)(1)).

In response to increased oversight of overall EFH program effectiveness by the Office of Management and Budget, NMFS established a quarterly reporting requirement to determine how many conservation recommendations are provided as part of each EFH consultation and how many are adopted by the action agency. Therefore, we ask that in your statutory reply to the EFH portion of this consultation, you clearly identify the number of conservation recommendations accepted.

3.5 Supplemental Consultation

The Corps and applicant must reinitiate EFH consultation with NMFS if the proposed action 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. FISH AND WILDLIFE COORDINATION ACT

The purpose of the FWCA is to ensure that wildlife conservation receives equal consideration, and is coordinated with other aspects of water resources development (16 USC 661). The FWCA establishes a consultation requirement for Federal agencies that undertake any action to modify any stream or other body of water for any purpose, including navigation and drainage (16 USC 662(a)), regarding the impacts of their actions on fish and wildlife, and measures to mitigate those impacts. Consistent with this consultation requirement, NMFS provides recommendations and comments to Federal action agencies for the purpose of conserving fish and wildlife resources, and providing equal consideration for these resources. NMFS' recommendations are provided to conserve wildlife resources by preventing loss of and damage to such resources. The FWCA allows the opportunity to provide recommendations for the conservation of all species and habitats within NMFS' authority, not just those currently managed under the ESA and MSA.

The following recommendations apply to the Proposed Action:

(1) The Corps should recommend that the project applicant install interpretive signs near the north and south entrances of the OWA as well as the two parking areas to help educate visitors about the ecological value of anadromous fish resources in the Oroville Wildlife Area and the Feather River.

The action agency must give these recommendations equal consideration with the other aspects of the proposed action so as to meet the purpose of the FWCA.

This concludes the FWCA portion of this consultation.

5. 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 opinion addresses these DQA components, documents compliance with the DQA, and certifies that this opinion has undergone pre-dissemination review.

5.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The Corps and SBFCA are the intended user of this opinion. Other interested users could include USFWS, CDFW, or DWR. Individual copies of this opinion were provided to the Corps and SBFCA. This opinion will be posted on the Public Consultation Tracking System web site (https://pcts.nmfs.noaa.gov/pcts-web/homepage.pcts). The format and naming adheres to conventional standards for style.

5.2 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 3 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.

5.3 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*.

Best Available Information: This consultation and supporting documents use the best available information, as referenced in the References section. The analyses in this opinion 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.

6. REFERENCES

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