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

JUN 05 2017

Refer to Tracking No: WCR-2017-7026

Nancy Haley, Chief
California 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 and Magnuson-Stevens Fishery Conservation and Management Act and Essential Fish Habitat Response for the Elder Creek Channel Rehabilitation Project

Dear Ms. Haley:

Thank you for your letter of 7 April 2017, requesting formal 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 Elder Creek Channel Rehabilitation Project.

Based on the best available scientific and commercial information, the Biological Opinion (Opinion) concludes that the Elder Creek Channel Rehabilitation Project is not likely to jeopardize the continued existence of the federally listed endangered Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*), Central Valley (CV) spring-run Chinook salmon ESU (*O. tshawytscha*), or the threatened California CV steelhead distinct population segment (*O. mykiss*), 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' essential fish habitat (EFH) consultation concludes that the proposed action would adversely affect the EFH of Pacific salmon in the action area. The EFH consultation adopts the ESA reasonable and prudent measures and associated terms and conditions from the Opinion and includes additional conservation recommendations specific to the adverse effects to EFH. This review was pursuant to section 305(b) of the of the Magnuson-Stevens Fishery Conservation and Management Act (MSA)(16 U.S.C. 1855(b)), implementing regulations at 50 CFR 600.920, and agency guidance for use of the ESA consultation process to complete EFH consultation.

The U.S. Army Corps of Engineers (Corps) has a statutory requirement under section 305(b)(4)(B) of the MSA to submit a detailed written response to NMFS within 30 days of receipt of these conservation recommendations, and 10 days in advance of any action, that includes a description of measures adopted by the Corps for avoiding, minimizing, or mitigating the impact of the project on EFH (50 CFR § 600.920(j)). If unable to complete a final response within 30 days, the Corps should provide an interim written response within 30 days before submitting its final response. In the case of a response that is inconsistent with our recommendations, the Corps must explain its reasons for not following the recommendations, including the scientific justification for any disagreements with NMFS over the anticipated effects of the Elder Creek Channel Rehabilitation Project and the measures needed to avoid, minimize, or mitigate (also referred to as compensate by NMFS) such effects.

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

Sincerely,

for Maria Rea
Barry A. Thom
Regional Administrator

Enclosure

cc: To the file: 151422-WCR2016-SA00238
Ms. Gabrielle Bohrer, California Department of Water Resources, gbohrer@water.ca.gov
Mr. Zac Fancher, U.S. Army Corps of Engineers, Zachary.J.Fancher@usace.army.mil

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

Elder Creek Channel Rehabilitation Project
National Marine Fisheries Service Consultation Number: **WCR-2017-7026**
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?
Sacramento River winter-run Chinook salmon ESU (*Oncorhynchus tshawytscha)*	Endangered	Yes	No	No
Central Valley spring-run Chinook salmon ESU (*O. tshawytscha)*	Threatened	Yes	No	No
California Central Valley steelhead (*O. mykiss*)	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	No

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

Issued By: Maria Rea
for Barry A. Thom
Regional Administrator

Date: JUN 05 2017

LIST OF ACRONYMS AND ABBREVIATIONS

ACID – Anderson-Cottonwood Irrigation Dam
BA – biological assessment
BMPs – Best Management Practices
CCV – California Central Valley
CCVAO – California Central Valley Area 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
Corps – United States Army Corps of Engineers
CV – Central Valley
CVP – Central Valley Project
CNFH – Coleman Nation Fish Hatchery
CR – County Road
CRR – cohort replacement rate
CVFPP – Central Valley Flood Protection Plan
CVRWQCB – Central Valley Regional Water Quality Control Board
CWA – Clean Water Act
DBH – diameter at breast height
DO – dissolved oxygen
DPS – distinct population segment
DQA – Data Quality Act
DWR – Department of Water Resources
EFH – essential fish habitat
EIR – environmental impact report
EPA – Environmental Protection Agency
EPOM – Environmental Permitting for Operations and Maintenance
ESA – Endangered Species Act
ESU – evolutionarily significant unit
FERC – Federal Energy Regulatory Commission
FMP – Fishery Management Program
FR – Federal Register
HAPC – habitat area of particular concern
HMMP – Hazardous Materials Management Plan
IPCC – Intergovernmental Panel on Climate Change
ITS – Incidental Take Statement
FRFH – Feather River Fish Hatchery
GIS – geographic information systems
JPE – juvenile production estimate
LSNFH – Livingston Stone National Fish Hatchery
LWM – large woody material
MSA – Magnuson-Stevens Fishery Conservation and Management Act
MSWE – mean surface water elevation

MSWL – mean surface water level
NLAA – not likely to adversely affect
NMFS – National Marine Fisheries Service
NOAA – National Oceanic and Atmospheric Administration
NPDES – National Pollutant Discharge Elimination System
NTUs – Nephelometric Turbidity Units
NWP – Nationwide Permit
OHWL – ordinary high water line
Opinion – biological opinion
PBF – physical or biological features
PCE – primary constituent elements
PL – Public Law
PVA – population viability analysis
RBDD – Red Bluff Diversion Dam
RM – river mile
RWQCB – Regional Water Quality Control Board
SJRRP – San Joaquin River Restoration Project
SPCCP – spill prevention, control, and counter-measure plan
SR – State Route
SRA – shaded riverine aquatic
SRCAF – Sacramento River Conservation Area Forum
SWE – snow water equivalent
SWIF – System Wide Improvement Framework
SWP – State Water Project
SWRCB – State Water Resources Control Board
SWPPP – stormwater pollution prevention plan
TCD – temperature control device
TCP – temperature compliance point
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

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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

The 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.

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 Area Office (CCVAO).

1.2 Consultation History

- **29 February 2016** – NMFS West Coast Region CCVAO received a consultation initiation request and Biological Assessment (BA) from the U.S. Army Corps of Engineers (Corps) for the Elder Creek Channel Rehabilitation Project. Listed species and critical habitats in the Action Area include the Sacramento River winter-run Chinook salmon evolutionarily significant unit (ESU) (*Oncorhynchus tshawytscha*) and their critical habitat; Central Valley (CV) spring-run Chinook salmon ESU and their critical habitat; and California Central Valley (CCV) steelhead distinct population segment (DPS) and their critical habitat.

- **20 May 2016** – NMFS sent an insufficiency letter outlining the information required before formal consultation could be initiated. The BA provided did not include the details of future operations and maintenance (O&M) activities, or describe in sufficient detail the manner in which the action may affect listed species and critical habitat.

- **13 July 2016** – NMFS staff Jahnava Duryea had a site visit to Elder Creek with the California Department of Water Resources (DWR) staff Gabrielle Bohrer (project lead), Kip Young, Scott Deal, and Corps staff Melissa France. DWR staff Casey Wilder, Shawn Freitag, and Jason Cooper from the Sutter Maintenance Yard met the group onsite (Tehama County, CA). At the site visit, Gabrielle Bohrer provided a written response to NMFS concerns.

- **26 September 2016** – NMFS staff Jahnava Duryea and Howard Brown had a meeting with DWR staff Gabrielle Bohrer, Kip Young, and Scott Deal to discuss project impacts and mitigation for channel rehabilitation activities.

- **4 April 2017 –** NMFS West Coast Region CCVAO received an informal consultation reinitiation request and revised BA from the Corps for the Elder Creek Channel Rehabilitation Project.

- **14 April 2017 –** NMFS West Coast Region CCVAO received a formal consultation request and revised BA from the Corps (Corps) for the Elder Creek Channel Rehabilitation Project.

- **25 May 2017** – NMFS staff Jahnava Duryea and DWR staff Gabrielle Bohrer had a phone conversation to clarify DWR's long-term maintenance pathway for Elder Creek. Ms. Bohrer sent an email summarizing the discussion.

A complete administrative record is on file and the NMFS California Central Valley Area Office.

1.3 Proposed 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 has issued a permit (SPK-2015-01073) to DWR, under its Nationwide Permit #3 and the statutory authority of Section 10 of the Rivers and Harbors Act of 1899 (33 U.S.C. § 403), and Section 404 of the Clean Water Act (33 U.S.C. § 1344), authorizing a 5-year construction on the Elder Creek Channel, which is noted to have flood management and channel capacity and maintenance deficiencies. DWR proposes to restore flood management capacity and correct these deficiencies by removing vegetation and sediment. The Proposed Action will allow Elder Creek to pass design flows at stage levels at or below the 1957 design profile and maintain active eligibility status for receiving Public Law (PL) 84-99 rehabilitation funding. The Corps of Engineers PL 84-99 program is a federal rehabilitation assistance program designed to provide financial aid in the event of flooding. For a non-Federal flood control project to be eligible for Rehabilitation Assistance, it must have been inspected, evaluated, and accepted into the Corps Rehabilitation and Inspection Program (*i.e.*, granted Active status) prior to the onset of the flood, and still be active (based on the latest Continuing Eligibility Inspection) at the time of the flood (USACE 2009).

The Proposed Action would provide flood protection to the town of Gerber, major and minor roadways (State Route [SR] 99 and County Route A8), rural residents, railroads (Southern Pacific Railroad), agricultural lands, and the Tehama-Colusa Canal. The Proposed Action would result in the removal of approximately 100,000 cubic yards of sediment from the channel and 4.05 acres of riparian vegetation along Elder Creek. Project impacts include loss of natural cover, substrate, habitat complexity, and food resources along a 4-mile reach of the Elder Creek stream channel due to the removal of sediment and woody riparian vegetation.

1.3.1 Project Location

The Proposed Action is located in the channel of Elder Creek located near the town of Gerber, California, about 9 miles southeast of Red Bluff in Tehama County (
Figure 1). The Elder Creek watershed drains runoff from the east side of the North Coast Range and the Sacramento Valley floor into the Sacramento River east of the town of Gerber. The Sacramento Valley floor reach of Elder Creek is an intermittent stream with flows generally occurring from November to May. From June through October, lower Elder Creek is dry in most years.

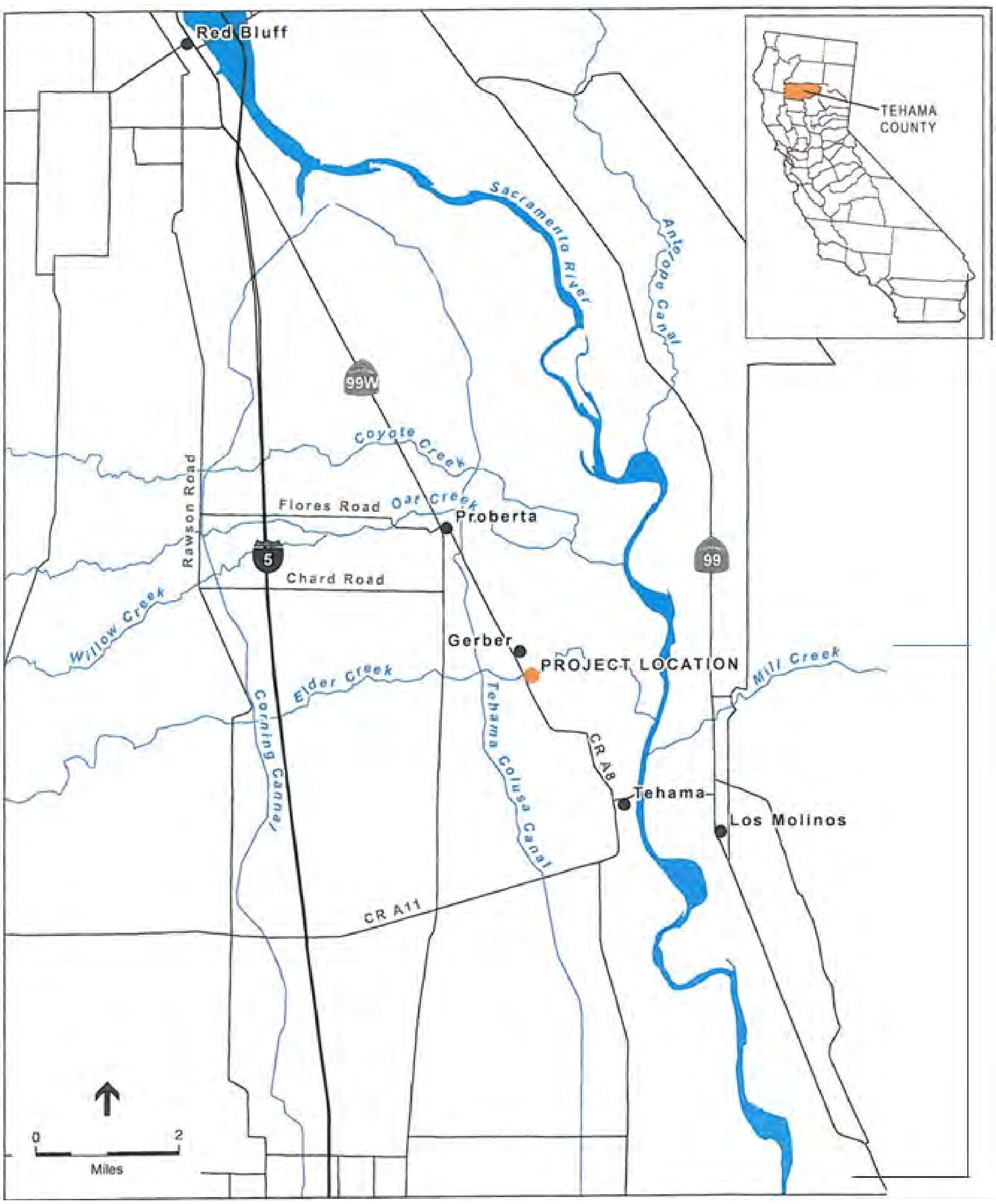


Figure 1. Regional Map of the Project Location.

1.3.2 Project Description

The Sutter Maintenance Yard, operated by DWR, will conduct the five components of the project including (1) vegetation removal, (2) sediment removal, (3) disposal and haul of removed materials, (4) revegetation with native plant species, and (5) erosion control in and around the Elder Creek channel. Construction is anticipated to be completed as a staged, 5-year process, with various components occurring each year and sometimes repeated from year to year. It is anticipated that up to 1 mile of channel would be disturbed each construction season. Heavy construction equipment that may be utilized by the contractor over the duration of the Project includes: masticators, mowers, chainsaws, loaders, excavators, scrapers, dump trucks, and water trucks
Table 1).

Table 1. Construction equipment and estimated annual usage.

Equipment Type	# of Each	Estimated HP	Hours Used Annually
Vegetation removal			**4 weeks**
pickup trucks (similar to F-150)	2	325	160
mowers	2	171	160
masticators	2	171	160
chainsaws	2	81	160
dump trucks	2	400	160
excavators	2	162	160
loaders	2	97	160
Herbicide Spot Treatment			**2 weeks**
pickup trucks	2	325	80
Sediment Removal			**8 weeks**
dump trucks	2	400	400
excavators	2	162	400
loaders	2	97	400

Work Window

The proposed work window is from May 1 to October 31 of each year over the 5-year period, with work continuing at the completed reach of the previous year. If dry weather patterns persist after October 31, in consultation with appropriate agencies, work will continue until a wet weather pattern begins to develop. Project timeline estimates are assuming 5-day work weeks and 10-hour work shifts, however; the work is being planned to take place over an extended period of time based on available resources and schedule conflicts. DWR workload will be dependent on the previous winter storm water impacts, budget constraints, and regulated work windows.

Long-term O&M is not being proposed as part of this project. Future O&M is expected to be covered by DWR's Environmental Permitting for Operations and Maintenance (EPOM) effort, through a Corps System-wide Improvement Framework (SWIF) plan that is currently being developed. Potential impacts to federally-listed species from long-term O&M activities along Elder Creek will be addressed through the SWIF effort. For this project, once received, the Corps Nationwide Permit (NWP) 31 will be adhered to for all activities.

Vegetation Removal and Herbicide Spot Treatment

The vegetation removal is needed to meet the flow conveyance capacity requirements and to provide a project site that can continue to be maintained by DWR staff. Vegetation management will consist of removing stands of the invasive giant reed (*Arundo donax*) and riparian vegetation. All giant reed and riparian vegetation to be removed will be cut within 6 inches of the ground and treated with Roundup® or other approved herbicide(s). In the areas set for thinning, vegetation less than 4 inches diameter at breast height (DBH) (*i.e.*, small trees, shrubs, and vines) will be removed, and remaining vegetation will be limbed up to 8 feet in height. Cut and trimmed vegetation will be off-hauled to a nearby permitted waste facility or stockpiled and burned on site. Disturbed soil will be reseeded with a native grass seed mix specified by the environmental permits. It is estimated to take approximately 4 weeks to perform the vegetation removal and approximately 2 weeks to perform any vegetation spot treatments prior to the removal of sediment.

Sediment Removal

If habitat conditions allow, sediment removal work will likely begin at the downstream, east end of the Action Area. DWR will mobilize excavators, dump trucks, and loaders to the site. Once equipment is mobilized, excess sediment would be removed from the channel and loaded into 10-wheel dump trucks or scrapers. Dump trucks and/or scrapers will then transport removed sediment to the spoils location. All finish grading within the channel will be conducted in a manner that minimizes the potential for depressions to form during the following wet season(s). This project component has been included to avoid and/or minimize the potential for pooling of water and associated potential for fish stranding. The sediment disposal site is located approximately 1 mile north of Elder Creek near East Chard and Main Avenues (Figure 2) off of San Benito Avenue. It will require approximately 8 weeks to remove the sediment.

Figure 2. Map of action area and project site boundary.

Haul Roads, Access Roads, and Staging

The staging areas for the sediment and vegetation removals will be limited to the Elder Creek channel and the existing levee crown and toe roads. No vegetated areas will be disturbed for the purpose of staging materials or equipment. The haul routes and access roads for the sediment and vegetation removals will be limited to County Roads, existing levee crown road, channel, and existing right-of-way access points along Elder Creek. No new roadways will be constructed for this project. There are three alternative haul routes and selection of the preferred route would occur each year based on seasonal conditions. When that route is selected, it would be delineated prior to construction beginning and encroachment permits would be obtained through the appropriate municipalities.

1.3.3 Conservation Measures

The following conservation measures will be implemented to avoid or minimize potential adverse effects on federally listed fish and wildlife species:

1) Project Design Refinements

   Original determinations, based on hydraulic analyses conducted, called for the removal of approximately 26 acres of giant reed, 21 acres of miscellaneous riparian vegetation (*e.g.*, clearing of vegetation < 4 inches DBH), 308 elderberry shrubs, and 150,000 cubic yards of sediment. In an effort to minimize the environmental impacts, additional hydraulic analyses were performed on the channel. As a result of the analyses, DWR found a scenario that met the hydraulic design guidelines of the channel while greatly reducing the impacts to the surrounding native vegetation.

The new scenario consists of removing all giant reed, 4.05 acres of miscellaneous riparian vegetation, 1.78 acres of elderberry shrubs (approximately 18 shrubs), and 100,000 cubic yards of sediment from the channel. In addition, approximately 1.4 acres of mature riparian would be trimmed/limbed. The new scenario would greatly reduce impacts to elderberry shrubs and riparian vegetation. Riparian vegetation to be removed was reduced from 21 acres to 4.05 acres, which would spare approximately 17 acres of mature riparian vegetation.

2) Protective barrier fencing around sensitive biological resources

Prior to each construction season, DWR staff (including environmental staff) will perform construction staking around the perimeter of the area planned for sediment removal and flagging around the areas designated for vegetation removal/thinning, so as to not disturb areas which will not be worked on that year. This will include delineation of site access and haul route locations on-site for the vegetation and the sediment removal for that specific season. Water for dust control during vegetation management and sediment removal/ hauling activities will be obtained from the Gerber-Las Flores Community Services District and stored in water trucks onsite.

3) Invasive plant species protection measures

All giant reed will be removed from the project site or burned on site. Giant reed is a very hardy and persistent invasive species that requires additional treatment to ensure that re-growth does not occur from the root balls. DWR staff will remove and/or treat the giant reed stumps with herbicides in the spring and fall as needed to ensure they do not re-sprout.

4) Best Management Practices (BMPs) for Water Quality and Aquatic Habitat Protection

In order to minimize effects of the Proposed Action to water quality and aquatic habitat, a number of BMPs and avoidance measures have been incorporated into the project design. All work will be conducted when the channel is dry. Construction of the project is not expected to result in increased levels of water pollution or otherwise violate water quality standards. Compliance with the National Pollutant Discharge Elimination System (NPDES) Permit for Discharges of Stormwater Associated with Construction Activities (NPDES General Stormwater Permit), from the Regional Water Quality Control Board (RWQCB) shall be implemented to avoid exceedance of applicable water quality standards.

5) Storm Water Pollution Prevention Plan (SWPPP)

Development and implementation of a SWPPP with BMPs for construction activities would reduce potential impacts to listed fishes and other aquatic species and habitat resulting from sedimentation and turbidity.

6) Hazardous Materials Management Plan (HMMP)

DWR shall prepare and implement an HMMP for the storage of liquefied petroleum gas and other hazardous materials above threshold quantities required for project operation. The HMMP would include (1) a hazardous materials inventory comprised of Material Safety Data Sheets for hazardous materials and contact information, (2) would outline requirements for employee training and for servicing/refueling equipment, and (3) would describe evacuation and emergency response procedures. Fuel and lubricants would be stored in containers and areas (*i.e.*, secondary containment) that conform to State and local regulations. Storage areas would have secondary containment of a size sufficient to contain a spill and prevent spreading. Spill prevention kits shall always be in close proximity when using hazardous materials (*e.g.*, crew trucks and other logical locations).

7) Implement Work Windows and Exclude Work Areas with Potential Fish Habitat

Based on NMFS recommendations, DWR has committed to exclude work areas in potential habitat to avoid direct impact to listed fishes. Exclusion areas include wetted channel and occurrence of ponded waters (pools) with fishes. These areas will be avoided until the channel completely dries and fishes are no longer present. Project work will proceed once the potential of take to listed fishes is made by DWR environmental staff.

8) Finish Grade the Elder Creek Channel to Minimize Potential for Fish Stranding

Finish grading within the channel shall be conducted in a manner that minimizes the potential for depressions to form the following wet season. However, natural channel bedscouring from higher flows may reform pools and DWR will not be obligated to regrade the channel bed caused by these natural events.

9) Mitigation Credits

DWR proposes to implement advance, off-site compensatory mitigation measures to compensate for long-term impacts to riparian and riverine habitat. Specific to the Elder Creek Channel Rehabilitation Project, DWR will provide compensatory mitigation for the permanent loss of 4.05 acres of riparian habitat by purchasing 12.15 salmonid/floodplain enhancement/creation credits at Westervelt Ecological Service's Bullock Bend Mitigation Bank in Yolo County to fulfill the requirements of Section 7 consultation. This compensatory mitigation proposal applies a 3:1 ratio for the unavoidable impacts to riparian vegetation based on site-specific information and determined through coordination with NMFS during the informal consultation process. Compensatory mitigation credits will be purchased prior to construction.

1.4 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 populations of salmon and steelhead may be affected by the implementation of the proposed action. The action area for the proposed channel rehabilitation of Elder Creek extends beyond its confluence with the mainstem Sacramento River at RM 230. The action area also encompasses the Bullock Bend Mitigation Bank along the Sacramento River at RM 106.

The proposed action is located on Elder Creek, near the town of Gerber, CA, about 11 miles southeast of Red Bluff. The Action Area includes the Elder Creek channel and adjacent areas beginning approximately 1 mile west of SR 99 and extending east in and around the channel for approximately 4 miles, ending 1 mile east of Tehama Road (Figure 2). 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 for the Elder Creek Channel Rehabilitation Project is defined as the creek channel and banks within the footprint of the proposed rehabilitation activities up to the ordinary high water mark (OHWM), associated riparian areas along the creek bank, and the waters of the Sacramento River extending across the width of the river and several hundred feet upstream and downstream of the confluence with Elder Creek. The channel rehabilitation construction sections, in addition to the mainstem Sacramento River, could be affected by temporary increases in turbidity and sedimentation in the wet season following channel construction activities. The length of the channel rehabilitation is 4 miles. The action area functions primarily as a rearing and migratory habitat for juvenile Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead.

"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 Elder Creek Channel Rehabilitation Project.

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.

The adverse modification analysis considers the impacts of the Federal action on the conservation value of designated critical habitat. This biological opinion does not rely on the regulatory definition of "destruction or adverse modification" of critical habitat at 50 CFR § 402.02. Instead, we have relied upon the statutory provisions of the ESA to complete the following analysis with respect to critical habitat.[1]

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

1) Identify the rangewide status of the species and critical habitat likely to be adversely affected by the proposed action.
2) Describe the environmental baseline in the action area.
3) Analyze the effects of the proposed action on both species and their habitat using an "exposure-response-risk" approach.
4) Describe any cumulative effects in the action area.
5) Integrate and synthesize the above factors to assess the risk that the proposed action poses to species and critical habitat.
6) Reach jeopardy and adverse modification conclusions.
7) If necessary, define a reasonable and prudent alternative to the proposed action.

2.1.1 Use of Analytical Surrogates

The effects of the Elder Creek Channel Rehabilitation Project on federally listed fish species are primarily analyzed by using habitat disturbance as an ecological surrogate for take. Descriptions of the habitat disturbance anticipated during the rehabilitation of the Elder Creek channel, including invasive species removal, SRA (shaded riverine aquatic) cover and riparian habitat loss, sediment removal, and project site operations and maintenance were provided in the biological assessment.

[1] Memorandum from William T. Hogarth to Regional Administrators, Office of Protected Resources, NMFS (Application of the "Destruction or Adverse Modification" Standard Under Section 7(a)(2) of the Endangered Species Act) (November 7, 2005).

2.1.2 Taking Conservation or Mitigation Banks into Consideration in the Effects Analysis and the Environmental Baseline

Conservation (or mitigation) banks present a unique situation in terms of how they are used in the context of the Effects Analysis and the Environmental Baseline in ESA section 7 consultations.

When NMFS is consulting on a proposed action that includes conservation bank credit purchases, it is likely that physical restoration work at the bank site has already occurred and/or that a Section 7 consultation occurred at the time of bank establishment. A traditional interpretation might suggest that the overall ecological benefits of the conservation bank actions belong in the Environmental Baseline. Under this interpretation, where proposed actions include credit purchases, it would not be possible to attribute their benefits to the proposed action, without double-counting. Such an interpretation does not reflect the unique circumstances that conservation banks serve. Specifically, conservation banks are established based on the expectation of future credit purchases. Conservation banks would not be created and their net beneficial effects would not occur in the absence of this expectation.

For these reasons, it is appropriate to treat the beneficial effects of the bank as accruing in connection with and at the time of specific credit purchases, not at the time of bank establishment or at the time of bank restoration work. This means that, in formal consultations on projects within the service area of a conservation bank, the beneficial effects of a conservation bank should be accounted for in the Environmental Baseline after a credit transaction has occurred. More specifically, the Environmental Baseline section should mention the bank establishment (and any consultation thereon) but, in terms of describing beneficial effects, it should discuss only the benefits attributable to credits already sold. In addition, in consultations that include credit purchases as part of the proposed action, the proportional benefits attributable to those credit purchase should be treated as effects of the action. Conversely, where a proposed action does not credit purchases, it will not receive any direct offset associated with the bank. This approach preserves the value of the bank for its intended purposes, both for the value of the credits to the bank proponent and the net conservation value of the bank to listed species and their critical habitat.

This Opinion will analyze the beneficial effects of the credit transaction associated with the proposed action and recognizes the beneficial effects associated with the remainder of the credits at the bank that have not been subject to a transaction (and their associated ecological benefits) will not be considered in the Environmental Baseline.

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 the Central Valley Recovery Plan (NMFS 2014a), status reviews (NMFS 2016a, 2016b, 2016c), and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' current "reproduction, numbers, or distribution" as described in 50 CFR 402.02.

The Opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the current function of the physical and biological features that help to form that conservation value. This section analyzes the status of those federally-listed anadromous fish species found within Elder Creek and the greater Sacramento River basin, focusing on broader geographical scales, representing the entire range of the Sacramento River winter-run Chinook ESU, Central Valley spring-run Chinook ESU, and the distinct population segment (DPS) of California Central Valley (CCV) steelhead, or perhaps slightly more narrowly focused upon habitat within California's Central Valley (CV).

The designation of critical habitat for species uses the term primary constituent element (PCE) or essential features. The new critical habitat regulations (81 FR 7214) 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 Opinion, we use the term PBF to mean primary constituent or essential features, as appropriate for the specific critical habitat.

2.2.1 Endangered Species Act Listing Status and Critical Habitat

The descriptions of the status of species and conditions of the designated critical habitats in this Opinion are a synopsis of the detailed information available on NMFS' West Coast Regional website. The following federally listed species ESUs or DPSs and reasona occur in the action area and may be affected by the proposed action.

Sacramento River winter-run Chinook salmon (*O. tshawytscha*)

- Originally listed as threatened on 4 August 1989 (54 FR 32085)
- Reclassified as endangered on 4 January 1994 (59 FR 440)
- Reaffirmed as endangered on 28 June 2005 (70 FR 37160)
- Critical habitat designated on 16 June 1993 (58 FR 33212)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/sacramento_river_winter_run/sacramento_river_winter_run_chinook.html

Central Valley spring-run Chinook salmon (*O. tshawytscha*) ESU

- Listed as threatened 28 June 2005 (70 FR 37160)
- Critical habitat designated on 2 September 2005 (70 FR 52488)

http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/chinook/central_valley_spring_run/central_valley_spring_run_chinook.html

California Central Valley steelhead DPS (*O. mykiss*)

- Originally listed as threatened on 19 March 1998 (63 FR 13347)
- Reaffirmed as threatened on 15 August 2011 (76 FR 157)
- Critical habitat designated on 2 September 2005 (70 FR 52488)

  http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/salmon_and_steelhead_listings/steelhead/california_central_valley/california_central_valley_steelhead.html

The most recent biological information suggests that the extinction risk of these Pacific salmon ESUs and the CCV steelhead DPS indicate that their ESA classifications are appropriate and should be maintained (76 FR 50447; NMFS 2016a, b, c).

2.2.2 Sacramento Winter-run Chinook Salmon

2.2.2.1 Summary of ESU Viability

There are several criteria (only one is required) that would qualify the winter-run ESU at moderate risk of extinction, and since there is still only one population that spawns downstream of Keswick Dam, that population would be at high risk of extinction in the long-term according the criteria in Lindley *et al.* (2007). Recent trends in those criteria are (1) continued low abundance, (2) a negative growth rate over 6 years (2006–2012), which is two complete generations, (3) a significant rate of decline since 2006, and (4) increased risk of catastrophe from oil spills, wildfires, or extended drought (climate change). The most recent biological information suggests that the extinction risk of this ESU has increased since the last status review (NMFS 2011a) largely due to extreme drought and poor ocean conditions. The best available information on the biological status of the ESU and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate and should be maintained. Long-term recovery of this ESU will require improved freshwater habitat conditions, abatement of a wide range of threats, and the establishment of additional spawning areas in Battle Creek and the McCloud River.

2.2.2.2 Distribution

Table 2 gives the distribution and timing of winter-run Chinook salmon in the Sacramento River. Note that temporal occurrence varies depending on the life stage.

Table 2. Temporal occurrence of adult (a) and juvenile (b) winter-run in the Sacramento River. Darker shades indicate months of greatest relative abundance.

Winter run relative abundance	High				Medium				Low			
a) Adults freshwater												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River basin[a,b]												
Upper Sacramento River spawning[c]												
b) Juvenile emigration												
Location	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Sacramento River at Red Bluff[d]												
Sacramento River at Knights Landing[e]												
Sacramento trawl at Sherwood Harbor[f]												
Midwater trawl at Chipps Island[g]												

Sources: [a] (Yoshiyama et al. 1998); (Moyle 2002); [b](Myers et al. 1998a) ; [c] (Williams 2006) ; [d] (Martin et al. 2001); [e] Knights Landing Rotary Screw Trap Data, CDFW (1999-2011); [f,g] Delta Juvenile Fish Monitoring Program, USFWS (1995-2012)

2.2.2.3 Critical Habitat: Physical and Biological Features for Sacramento River Winter-run Chinook Salmon

NMFS designated critical habitat for winter-run Chinook salmon on June 16, 1993 (58 FR 33212). Critical habitat was delineated as the Sacramento River from Keswick Dam at river mile (RM) 302 to Chipps Island, RM 0, at the westward margin of the Sacramento-San Joaquin Delta (Delta), including Kimball Island, Winter Island, and Brown’s Island; all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge, and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. In the Sacramento River, critical habitat includes the river water, river bottom, and the adjacent riparian zone.

Critical habitat for winter-run is defined as specific areas (listed below) that contain the PBFs considered essential to the conservation of the species. This designation includes the river water, river bottom (including those areas and associated gravel used by winter-run as spawning substrate), and adjacent riparian zone used by fry and juveniles for rearing (June 16, 1993, 58 FR 33212). NMFS limits “adjacent riparian zones” to only those areas above a stream bank that provide cover and shade to the nearshore aquatic areas. Although the bypasses (*e.g.*, Yolo, Sutter, and Colusa) are not currently designated critical habitat for winter-run, NMFS recognizes that they may be utilized when inundated with Sacramento River flood flows and are important rearing habitats for juvenile winter-run. Also, juvenile winter-run may use tributaries of the Sacramento River for non-natal rearing. Critical habitat also includes the estuarine water column and essential foraging habitat and food resources used by winter-run as part of their juvenile outmigration or adult spawning migration.

Currently, many of these physical and biological features are degraded and provide a limited amount of high quality habitat. Additional features that lessen the quality of the migratory corridor for juveniles include unscreened diversions, altered flows in the Delta, and the lack of floodplain habitat. Although the habitat for winter-run has been highly degraded, the importance of the existing spawning habitat, migratory corridors, and rearing habitat that remains is of high conservation value.

The following is the status of the PBFs that are considered to be essential for the conservation of winter-run (June 16, 1993, 58 FR 33212):

1. <u>Access from the Pacific Ocean to Appropriate Spawning Areas</u>

Adult migration corridors should provide satisfactory water quality, water quantity, water temperature, water velocity, cover, shelter and safe passage conditions in order for adults to reach spawning areas. Adult winter-run generally migrate to spawning areas during the winter and spring. At that time of year, the migration route is accessible to the appropriate spawning grounds on the upper 60 miles of the Sacramento River, however much of this migratory habitat is degraded and they must pass through a fish ladder at the Anderson-Cottonwood Irrigation Dam (ACID). In addition, the many flood bypasses are known to strand adults in agricultural drains due to inadequate screening (Vincik and Johnson 2013). Since the primary migration corridors 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.

2. <u>The Availability of Clean Gravel for Spawning Substrate</u>

Suitable spawning habitat for winter-run exists in the upper 60 miles of the Sacramento River between Keswick Dam and Red Bluff Diversion Dam (RBDD). However, the majority of spawning habitat currently being used occurs in the first 10 miles downstream of Keswick Dam. The available spawning habit is completely outside the historical range utilized by winter-run upstream of Keswick Dam. Because Shasta and Keswick dams block gravel recruitment, the U.S. Bureau of Reclamation (Reclamation) annually injects spawning gravel into various areas of the upper Sacramento River. With the supplemented gravel injections, the upper Sacramento River reach continues to support a small naturally-spawning winter-run Chinook salmon population. 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.

3. Adequate River Flows for Successful Spawning, Incubation of Eggs, Fry Development and Emergence, and Downstream Transport of Juveniles

An April 5, 1960, Memorandum of Agreement between Reclamation and the California Department of Fish and Game (CDFG) originally established flow objectives in the Sacramento River for the protection and preservation of fish and wildlife resources. In addition, Reclamation complies with the 1990 flow releases required in State Water Resource Control Board (SWRCB) Water Rights Order (WRO) 90-05 for the protection of Chinook salmon. This order includes a minimum flow release of 3,250 cubic feet per second (cfs) from Keswick Dam downstream to RBDD from September through February during all water year types, except critically dry.

4. Water Temperatures at 5.8–14.1°C (42.5–57.5°F) for Successful Spawning, Egg Incubation, and Fry Development

Summer flow releases from Shasta Reservoir for agriculture and other consumptive uses drive operations of Shasta and Keswick dam water releases during the period of winter-run migration, spawning, egg incubation, fry development, and emergence. This pattern, the opposite of the pre-dam hydrograph, benefits winter-run by providing cold water for miles downstream during the hottest part of the year. The extent to which winter-run habitat needs are met depends on Reclamation's other operational commitments, including those to water contractors, Delta requirements pursuant to State Water Rights Decision 1641 (D-1641), and Shasta Reservoir end of September storage levels required in the NMFS 2009 OPINION (NMFS 2009) on the long-term operations of the CV Project and State Water Project (CVP/SWP). WRO 90-05 and 91-1 require Reclamation to operate Shasta, Keswick, and Spring Creek Powerhouse to meet a daily average water temperature of 13.3°C (56°F) at RBDD. They also provide the exception that the water temperature compliance point (TCP) may be modified when the objective cannot be met at RBDD. Based on these requirements, Reclamation models monthly forecasts and determines how far downstream 13.3°C (56°F) can be maintained throughout the winter-run spawning, egg incubation, and fry development stages.

In every year since WRO 90-05 and 91-1 were issued, operation plans have included modifying the TCP to make the best use of the cold water available based on water temperature modeling and current spawning distribution. Once a TCP has been identified and established in May, it generally does not change, and therefore, water temperatures are typically adequate through the summer for successful winter-run egg incubation and fry development for those redds constructed upstream of the TCP (except for in some critically dry and drought years). However, by continually moving the TCP upstream, the value of that habitat is degraded by reducing the spawning area in size and imprinting upon the next generation to return further upstream.

5. Habitat and Adequate Prey Free of Contaminants

Water quality conditions have improved since the 1980s due to stricter standards and Environmental Protection Agency (EPA) Superfund site cleanups (see Iron Mountain Mine remediation under Factors). No longer are there fish kills in the Sacramento River caused by the heavy metals (*e.g.,* lead, zinc and copper) found in the Spring Creek runoff. However, legacy contaminants such as mercury (and methyl mercury), polychlorinated biphenyls (PCB), heavy metals and persistent organochlorine pesticides continue to be found in watersheds throughout the CV. In 2010, the EPA, listed the Sacramento River as impaired under the Clean Water Act, section 303(d), due to high levels of pesticides, herbicides, and heavy metals (http://www.waterboards.ca.gov/water_issues/programs/tmdl/2010state_ir_reports/category5_report.shtml). Although most of these contaminants are at low concentrations in the food chain, they continue to work their way into the base of the food web, particularly when sediments are disturbed and previously entombed compounds are released into the water column.

Adequate prey for juvenile salmon to survive and grow consists of abundant aquatic and terrestrial invertebrates that make up the majority of their diet before entering the ocean. Exposure to these contaminated food sources such as invertebrates may create delayed sublethal effects that reduce fitness and survival (Laetz *et al.* 2009). Contaminants are typically associated with areas of urban development, agriculture, or other anthropogenic activities (*e.g.*, mercury contamination as a result of gold mining or processing). Areas with low human impacts frequently have low contaminant burdens, and therefore lower levels of potentially harmful toxicants in the aquatic system. Freshwater rearing habitat has a high intrinsic conservation value even if the current conditions are significantly degraded from their natural state.

6. <u>Riparian and Floodplain Habitat that Provides for Successful Juvenile Development and Survival</u>

The channelized, leveed, and riprapped river reaches and sloughs that are common in the Sacramento River system typically have low habitat complexity, low abundance of food organisms, and offer little protection from predators. Juvenile life stages of salmonids are dependent on the natural functioning of this habitat for successful survival and recruitment. Ideal habitat contains natural cover, such as riparian canopy structure, submerged and overhanging large woody material (LWM), aquatic vegetation, large rocks and boulders, side channels, and undercut banks which augment juvenile and adult mobility, survival, and food supply. Riparian recruitment is prevented from becoming established due to the reversed hydrology (*i.e.*, high summer time flows and low winter flows prevent tree seedlings from establishing). However, there are some complex, productive habitats within historical floodplains [*e.g.*, Sacramento River reaches with setback levees (*i.e.*, primarily located upstream of the City of Colusa)] and flood bypasses (*i.e.*, fish in Yolo and Sutter bypasses experience rapid growth and higher survival due to abundant food resources) seasonally available that remain in the system. Nevertheless, the current condition of degraded riparian habitat along the mainstem Sacramento River restricts juvenile growth and survival (Michel 2010; Michel *et al.* 2012).

7. <u>Access Downstream so that Juveniles can Migrate from the Spawning Grounds to San Francisco Bay and the Pacific Ocean</u>

Freshwater emigration corridors should be free of migratory obstructions, with water quantity and quality conditions that enhance migratory movements. Migratory corridors are downstream of the Keswick Dam spawning areas and include the mainstem of the Sacramento River to the Delta, as well as non-natal rearing areas near the confluence of some tributary streams.

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. Unscreened diversions that entrain juvenile salmonids are prevalent throughout the mainstem Sacramento River and in the Delta. Predators such as striped bass (*Morone saxatilis*) and Sacramento pikeminnow (*Ptychocheilus grandis*) tend to concentrate immediately downstream of diversions, resulting in increased mortality of juvenile Chinook salmon.

Water pumping at the CVP/SWP export facilities in the South Delta at times causes the flow in the river to move back upstream (reverse flow), further disrupting the emigration of juvenile winter-run by attracting and diverting them to the interior Delta, where they are exposed to increased rates of predation, other stressors in the Delta, and entrainment at pumping stations. NMFS' Opinion on the long-term operations of the CVP/SWP (NMFS 2009) sets limits to the strength of reverse flows in the Old and Middle Rivers, thereby keeping salmon away from areas of highest mortality. Regardless of the condition, the remaining estuarine areas are of high conservation value because they provide factors which function as rearing habitat and as an area of transition to the ocean environment.

2.2.2.4 Description of Viable Salmonid Population (VSP) Parameters

As an approach to evaluate the likelihood of viability of the Sacramento River winter-run Chinook salmon ESU, and determine the extinction risk of the ESU, NMFS uses the Viable Salmonid Population (VSP) concept. In this section, we evaluate the VSP parameters of abundance, productivity, spatial structure, and diversity. These specific parameters are important to consider because they are predictors of extinction risk, and the parameters reflect general biological and ecological processes that are critical to the growth and survival of salmon (McElhany *et al.* 2000a).

2.2.2.4.1 Abundance

Historically, winter-run population estimates were as high as 120,000 fish in the 1960s, but declined to less than 200 fish by the 1990s (National Marine Fisheries Service 2011). In recent years, since carcass surveys began in 2001 (**Figure 3**), the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2013, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011 (**Figure 3**). This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2016a). A slight increase in 2014, with 3,015 adults, remains below the high within the last ten years.

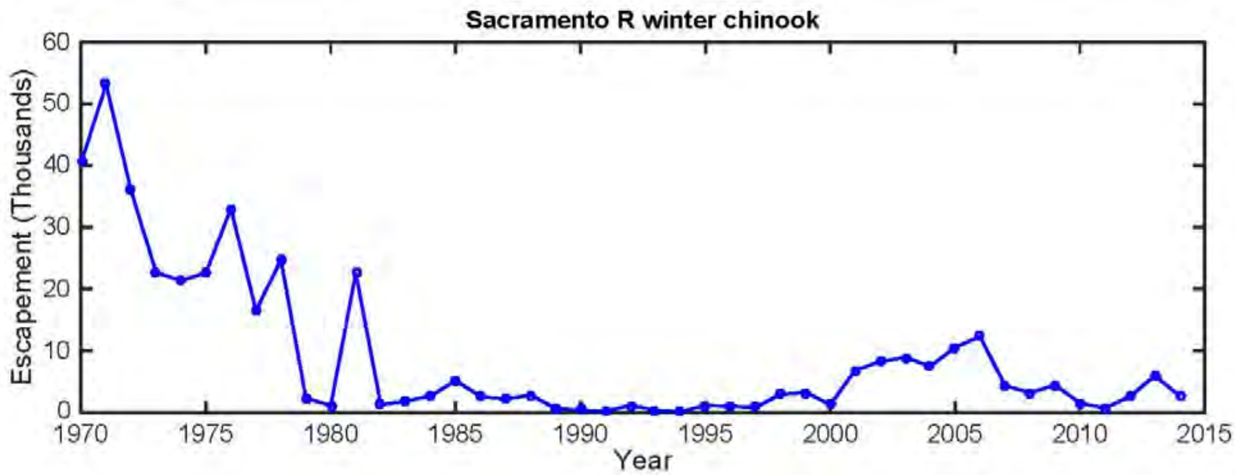


Figure 3. Time series of escapement for SR winter-run Chinook salmon populations spawning in-river. Estimates for in-river spawners is the average number of adults counted at Red Bluff Diversion Dam and the carcass survey mark-recapture estimates (when available). Note: only mark-recapture estimates used beginning in 2009; Data source: Azat 2014.

Although impacts from hatchery fish (*i.e.*, reduced fitness, weaker genetics, smaller size, decreased ability to avoid predators) are often cited as having deleterious impacts on natural in-river populations (Matala *et al.* 2012), the winter-run conservation program at Livingston Stone National Fish Hatchery (LSNFH) is strictly controlled by the USFWS to reduce such impacts. The average annual hatchery production at LSNFH is approximately 176,348 per year (2001–2010 average) compared to the estimated natural production that passes RBDD, which is 4.7 million per year based on the 2002–2010 average, (Poytress & Carrillo 2011). Therefore, hatchery production typically represents approximately 3-4 percent of the total in-river juvenile production in any given year.

2016 was the fifth year of a drought which increased water temperatures in the upper Sacramento River. This caused significantly higher mortality (95-97%) in the upper spawning area. Due to the anticipated lower than average survival in 2014-2015, hatchery production from LSNFH was tripled to offset the impact of the drought. In 2014, hatchery production represented 50-60% of the total in-river juvenile production. Drought conditions persisted into 2015 and a similar approach was attempted, however LSNFH staff have clearly noted a decline in health, and increase in prevalence and severity of fish pathogens in the adults collected at LSNFH during the past years of the most extreme drought conditions. This occurrence has significantly increased the level of pre-spawn mortality at LSNFH, reducing the potential for increased production.

2.2.2.4.2 Productivity

ESU productivity was positive over the period 1998–2006, and adult escapement and juvenile production had been increasing annually until 2007, when productivity became negative (Figure 2) with declining escapement estimates. The long-term trend for the ESU, therefore, remains negative, as the productivity is subject to impacts from environmental and artificial conditions.

The population growth rate based on cohort replacement rate (CRR) for the period 2007–2012 suggested a reduction in productivity (Figure 4), and indicated that the winter-run population was not replacing itself. In 2013, and 2014, winter-run experienced a positive CRR, possibly due to favorable in-river conditions in 2011, and 2012 (wet years), which increased juvenile survival to the ocean.

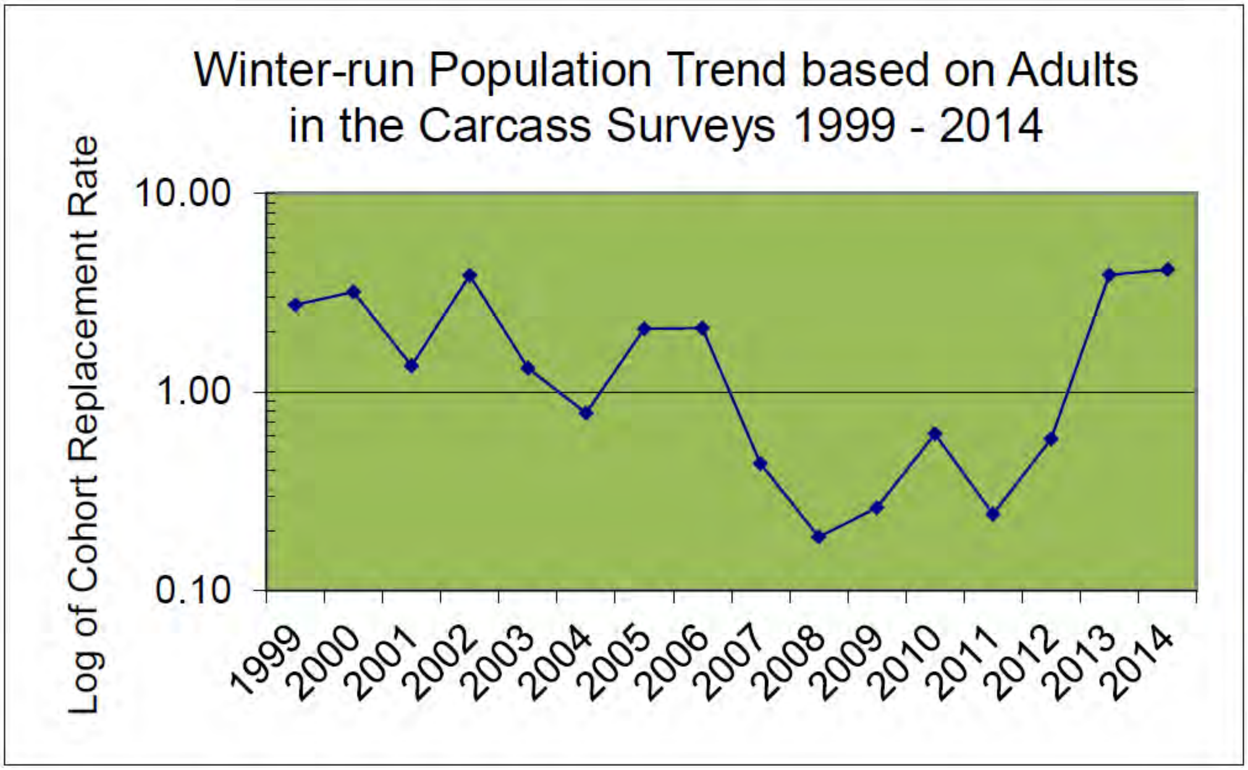


Figure 4. Winter-run population trend using cohort replacement rate derived from adult escapement, including hatchery fish, 1999–2014.

Productivity, as measured by the number of juveniles entering the Delta, or juvenile production estimate (JPE), has declined in recent years from a high of 3.8 million in 2007 to 124,521 in 2014. Due to uncertainties in the various JPE factors, it was updated in 2010 with the addition of confidence intervals (Cramer Fish Sciences model), and again in 2013, and 2014 with a change in survival based on acoustic tag data (National Marine Fisheries Service 2014b). However, juvenile winter-run productivity is still much lower than other Chinook salmon runs in the Central Valley and in the Pacific Northwest (Michel 2010).

2.2.2.4.3 Spatial Structure

Historically, the distribution of winter-run spawning and initial rearing was limited to Little Sacramento River (upstream of Shasta Dam), McCloud River, Pitt River, and Battle Creek, where springs provided cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (Slater 1963) *op. cit.* (Yoshiyama *et al.* 1998). The construction of Shasta Dam in 1943 blocked access to all of these waters except Battle Creek, which currently has its own impediments to upstream migration (*i.e.*, a number of small hydroelectric dams situated upstream of the Coleman National Fish Hatchery weir). The Battle Creek Salmon and Steelhead Restoration Project is currently removing these impediments, which should restore spawning and rearing habitat for winter-run in the future.

Approximately 299 miles of former tributary spawning habitat above Shasta Dam is inaccessible to winter-run. Most components of the winter-run life history (*e.g.*, spawning, incubation, freshwater rearing) have been compromised by the construction of Shasta Dam. The greatest risk factor for winter-run lies within its spatial structure (National Marine Fisheries Service 2011a). The remnant and remaining population cannot access 95 percent of their historical spawning habitat, and must therefore be artificially maintained in the Sacramento River by (1) spawning gravel augmentation, (2) hatchery supplementation, and, (3) regulating the finite cold-water pool behind Shasta Dam to reduce water temperatures. Winter-run require cold water temperatures in the summer that simulate their upper basin habitat, and they are more likely to be exposed to the impacts of drought in a lower basin environment. Battle Creek is currently the most feasible opportunity for the ESU to expand its spatial structure, but restoration is not scheduled to be completed until 2020. The Central Valley Salmon and Steelhead Recovery Plan includes criteria for recovering the winter-run Chinook salmon ESU, including re-establishing a population into historical habitats upstream of Shasta Dam (NMFS 2014a). Additionally, NMFS (2009) included a requirement for a pilot fish passage program above Shasta Dam, and planning is currently moving forward.

2.2.2.4.4 Diversity

The current winter-run population is the result of the introgression of several stocks (*e.g.,* springrun and fall-run Chinook) that occurred when Shasta Dam blocked access to the upper watershed. A second genetic bottleneck occurred with the construction of Keswick Dam which blocked access and did not allow spatial separation of the different runs (Good *et al.* 2005). Lindley *et al.* (2007) recommended reclassifying the winter-run population extinction risk from low to moderate, if the proportion of hatchery origin fish from the LSNFH exceeded 15 percent due to the impacts of hatchery fish over multiple generations of spawners. Since 2005, the percentage of hatchery-origin winter-run recovered in the Sacramento River has only been above 15 percent in two years, 2005 and 2012.

Concern over genetic introgression within the winter-run population led to a conservation program at LSNFH that encompasses best management practices such as (1) genetic confirmation of each adult prior to spawning, (2) a limited number of spawners based on the effective population size, and (3) use of only natural-origin spawners since 2009. These practices reduce the risk of hatchery impacts on the wild population. Hatchery-origin winter-run have made up more than 5 percent of the natural spawning run in recent years and in 2012, it exceeded 30 percent of the natural run. However, the average over the last 16 years (approximately 5 generations) has been 8 percent, still below the low-risk threshold (15 percent) used for hatchery influence (Lindley *et al.* 2007).

2.2.3 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 (70 FR 37160, June 28, 2005). 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, the majority of spring-run in the Central Valley were produced in the Southern Sierra Nevada Diversity Group, which contains the San Joaquin River and its tributaries. All spring-run populations in this diversity group have been extirpated and the CV spring-run Chinook salmon ESU is at moderate risk of extinction (Lindley *et al.* 2007). Lindley *et al.* (2007) determined that perhaps 15 of the 19 historical populations of spring-run are extinct, with their entire historical spawning habitats behind various impassable dams. 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.

While some conservation measures have been successful in improving habitat conditions for the CV spring-run Chinook salmon ESU since it was listed in 1999, fundamental problems with the quality of remaining habitat still remain (see Lindley et al. 2009, Cummins et al. 2008, and NMFS 2014). As such, the habitat supporting this ESU remains in a highly degraded state and it is unlikely that habitat quality has substantially changed since the last status review in 2010 (NMFS 2011). Overall, major habitat expansion and restoration for CV spring-run Chinook salmon has not occurred as of this review, and because of that, the loss of historical habitat and the degradation of remaining habitat continue to be major threats to the CV spring-run Chinook salmon ESU.

The most recent viability assessment of CV spring-run Chinook salmon was conducted during NMFS' 2016 status review, which found that the biological status of the ESU has improved since the last status review (NMFS 2016b). The recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2015 drought, and 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. NMFS concluded that the species' status should remain as previously listed (76 FR 50447).

2.2.3.1 Summary of ESU Viability

Lindley *et al.* (2007) only considered Butte, Deer, and Mill Creeks as watersheds with persistent populations of Chinook salmon known as spring-run, although they recognized that phenotypic Chinook salmon persist within the Feather River Hatchery population spawning in the Feather River below Oroville Dam and in the Yuba River below Englebright Dam. Viable CV spring-run Chinook salmon populations occur in only one of four diversity groups that historically contained them, and therefore fail the representation and redundancy rule for ESU viability (Lindley *et al.* 2007). All of those population fall within the Northern Sierra Nevada diversity group. Butte and Deer creek spring-run populations are at low risk of extinction, and the Mill Creek population is at either a moderate or low risk (Lindley *et al.* 2007). Mill, Deer, and Butte Creeks are close together geographically, decreasing the independence of their extinction risks due to catastrophic disturbance. These and other conditions covered in the 2011 status review have not changed since 2011. While the abundance for some populations appears to be slightly improving, the ESU is still demonstrating a high variability in adult abundance (especially in Butte Creek), we cannot say based on the trend over the past three years that the risk of extinction for the ESU has improved.

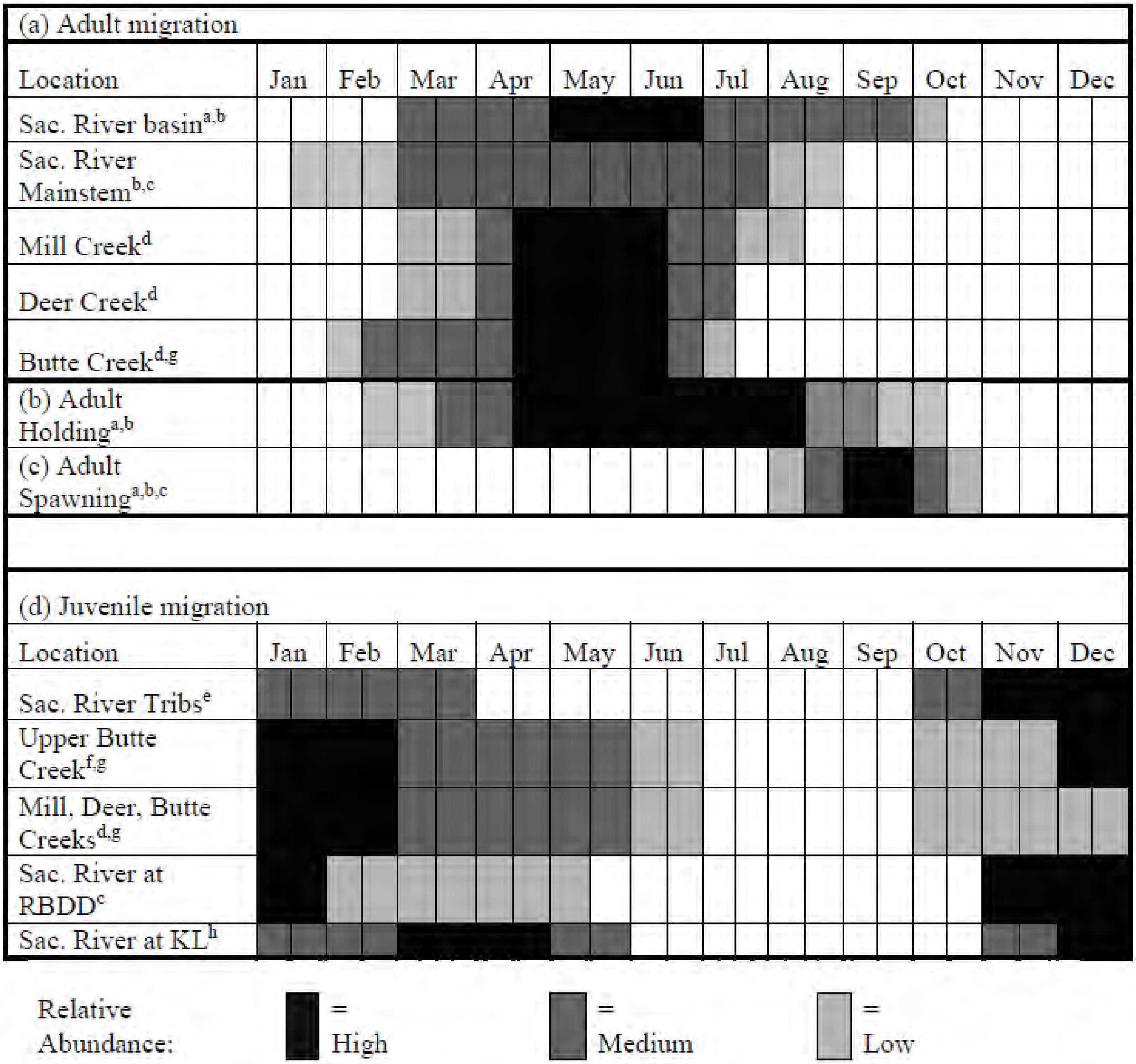
Since the populations in Butte, Deer and Mill creeks are the best trend indicators for ESU viability, we can evaluate risk of extinction based on VSP parameters in these watersheds. Lindley *et al.* (2007) indicated that the spring-run Chinook salmon populations in the Central Valley had a low risk of 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. 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. Drought is also considered to pose a significant threat to the viability of the spring-run Chinook salmon populations in these three watersheds due to their close proximity to each other. One large event could eliminate all three populations.

2.2.3.2 Distribution

The distribution and timing of spring-run Chinook salmon varies depending on the life stage, and is shown in

Table 3 below.

Table 3. 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.



Sources: [a](Yoshiyama et al. 1998); [b](Moyle 2002); [c]Myers *et al.* (1998b); [d]Lindley et al. (2004); [e]CDFG (1998); [f](McReynolds et al. 2007); [g]Ward et al. (2003); [h]Snider and Titus (2000) ; Note: Yearling spring-run Chinook salmon rear in their natal streams through the first summer following their birth. Downstream emigration generally occurs the following fall and winter. Most young-of-the-year spring-run Chinook salmon emigrate during the first spring after they hatch.

2.2.3.3 Critical Habitat: Physical and Biological Features for Central Valley spring-run Chinook Salmon

Critical habitat was designated for CV spring-run Chinook salmon on September 2, 2005 (70 FR

52488). Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches (70 FR 52488) and the lateral extent as defined by the ordinary high-water line (OHWL). In areas where the OHWL 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, Big Chico, Battle, Antelope, and Clear creeks. However, little spawning activity has been recorded in recent years on the upper Sacramento River mainstem for spring-run Chinook salmon. The majority occurs in the tributaries to the Sacramento River. 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 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 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 Corridor

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

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.

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. This PBF is outside of the action area for the proposed project.

2.2.3.4 Description of VSP Parameters

2.2.3.4.1 Abundance

Historically spring-run Chinook salmon were the second most abundant salmon run in the Central Valley and one of the largest on the west coast (CDFG 1990, 1998). These fish occupied the upper and middle elevation reaches (1,000 to 6,000 feet, now blocked by dams) 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 1872, Rutter 1904, Clark 1929).

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 still persist in the Stanislaus and Tuolumne, as well as the Yuba River. 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 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 the only 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 (CDFG Grandtab 2015).

Monitoring of the Sacramento River mainstem during spring-run Chinook salmon spawning timing indicates that 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. Fewer than 15 Chinook salmon redds per year were observed in the Sacramento River from 1989 to 1993, during September aerial redd counts (USFWS 2003). 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; 2012 observed zero redds, and 2013, 57 redds in September (CDFG, unpublished data, 2014). 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.

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 (Table 4). 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). Although trends were generally positive during this time, annual abundance estimates display a high level of fluctuation, and the overall number of CV spring-run Chinook salmon remained well below estimates of historic abundance.

Table 4. Central Valley Spring-run Chinook salmon population estimates from CDFW GrandTab (2015) with corresponding cohort replacement rates for years since 1990.

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
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	1.54	4,795	1.63	1.36
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	30,534	6,746	23,788	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	16,869	4,135	12,734	9,917	0.54	2.09	14,301	0.55	1.30
2002	17,224	4,189	13,035	12,242	2.13	2.35	16,733	1.75	1.46
2003	17,691	8,662	9,029	9,290	1.63	2.17	14,165	1.92	1.43
2004	13,612	4,212	9,400	9,948	0.74	1.79	14,919	0.81	1.37
2005	16,096	1,774	14,322	11,704	1.10	1.23	16,298	0.93	1.19
2006	10,948	2,181	8,767	10,911	0.97	1.31	15,114	0.62	1.21
2007	9,726	2,674	7,052	9,714	0.75	1.04	13,615	0.71	1.00
2008	6,368	1,624	4,744	8,857	0.33	0.78	11,350	0.40	0.69
2009	3,801	989	2,812	7,539	0.32	0.69	9,388	0.35	0.60
2010	3,792	1,661	2,131	5,101	0.30	0.54	6,927	0.39	0.49
2011	5,033	1,969	3,064	3,961	0.65	0.47	5,731	0.78	0.53
2012	14,724	3,738	10,986	4,747	3.91	1.10	6,744	0.72	0.53
2013	18,384	4,294	14,090	6,617	6.61	2.36	9,147	1.32	0.71
2014	8,434	2,776	5,658	7,186	1.85	2.66	10,073	1.76	0.99
Median	10,085	3,700	6,327	6,326	2.00	1.85	10,034	1.00	1.27

[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

From 2005 through 2011, abundance numbers in most of the tributaries declined. Adult returns from 2006 to 2009, indicate that population abundance for the entire Sacramento River basin is declining from the peaks seen in the five years prior to 2006. 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 2011b). 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 2011b). 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 appears to be lower, just over 5,000 fish, which indicates a highly fluctuating and unstable ESU abundance.

2.2.3.4.2 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.* 2000a). In general, declining productivity equates to declining population abundance. McElhany *et al.* (2000a) 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. 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 6). The productivity of the Feather River and Yuba River populations and contribution to the ESU currently is unknown, however the FRFH currently produces 2,000,000 juveniles each year. The CRR for the 2012 combined tributary population was 3.91, and 6.61 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.

2.2.3.4.3 Spatial Structure

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). All historical populations in the basalt and porous lava diversity group and the southern Sierra Nevada diversity group have been extirpated, although 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 mainstem river 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 2013).

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.

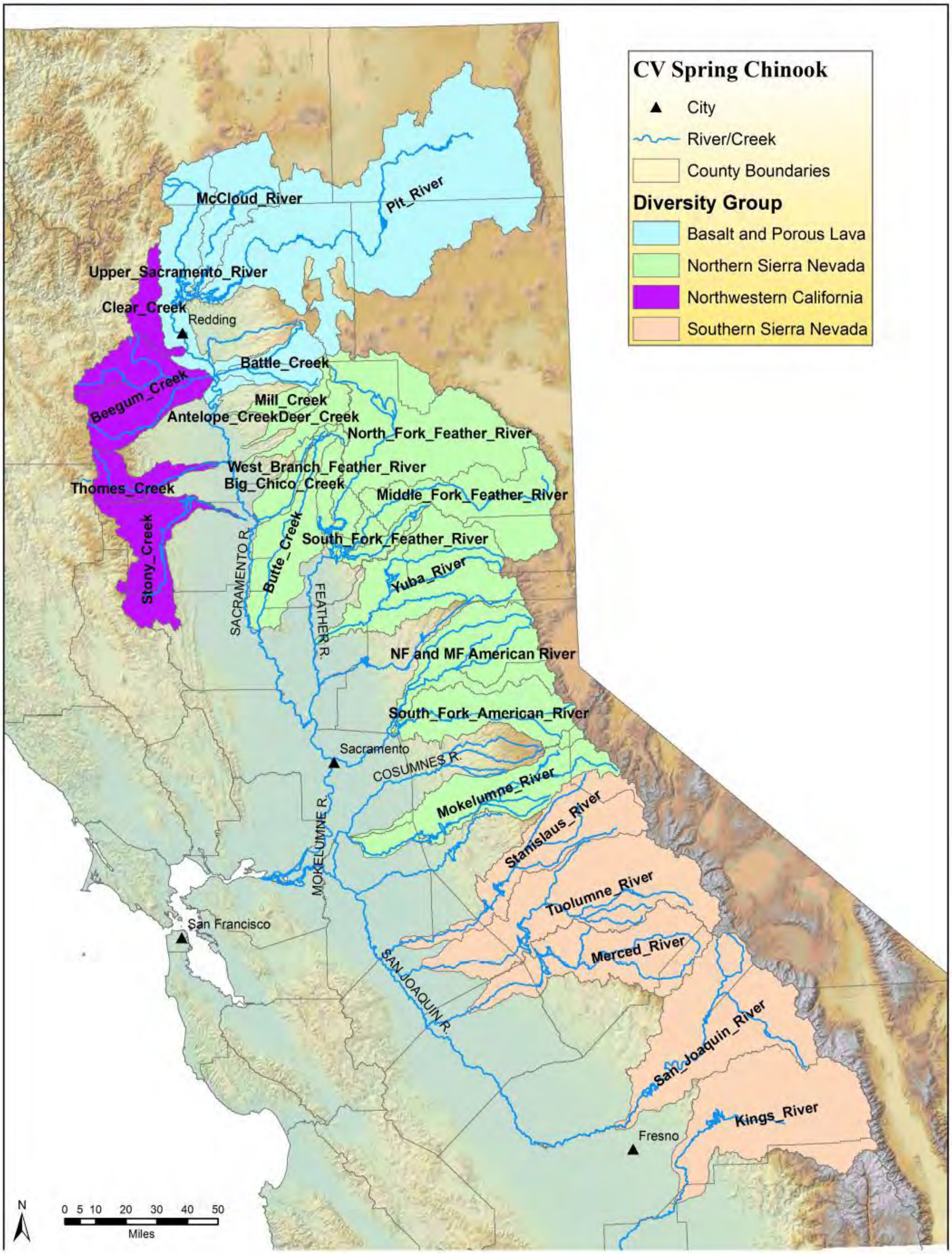


Figure 5. Diversity Groups for the Central Valley spring-run Chinook salmon ESU.

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 San Joaquin River Restoration Project (SJRRP) (78 FR 251; 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. However, the rule includes proposed protective regulations under ESA section 4(d) that would provide specific exceptions to prohibitions under ESA section 9 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. A second release occurred in 2015, and future releases are planned to continue annually during the spring. The SJRRP's future long-term contribution to the CV spring-run Chinook salmon ESU has yet to be determined.

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 (2014a). 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 2014a).

2.2.3.4.4 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.* 2000a). 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 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 retains 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.

2.2.4 California Central Valley Steelhead

CCV steelhead were listed as threatened on March 19, 1998 (63 FR 13347). Following a new status review (Good *et al.* 2005) and after application of the agency's hatchery listing policy, NMFS reaffirmed its status as threatened and also listed several hatchery stocks as part of the DPS in 2006 (71 FR 834). In June 2004, after a complete status review of 27 west coast salmonid ESUs and DPSs, the NMFS proposed that CCV steelhead remain listed as threatened (69 FR 33102). On January 5, 2006, the NMFS reaffirmed the threatened status of the CCV steelhead and applied the DPS policy to the species because the resident and anadromous life forms of *O. mykiss* remain "markedly separated" as a consequence of physical, ecological and behavioral factors, and therefore warranted delineation as a separate DPS (71 FR 834). In 2016, NMFS completed another 5-year status review of CCV steelhead and recommended that the CCV steelhead DPS remain classified as a threatened species (NMFS 2016c).

Overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration and dam removal efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain (NMFS 2016c).

The Central Valley has experienced a severe drought during 2012 through 2016, which has 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 two 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 2009 OCAP BO, 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.

2.2.4.1 Summary of 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 2011c). 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.

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 2011c). The most recent status review of the CCV steelhead DPS (NMFS 2011c) 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.

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.

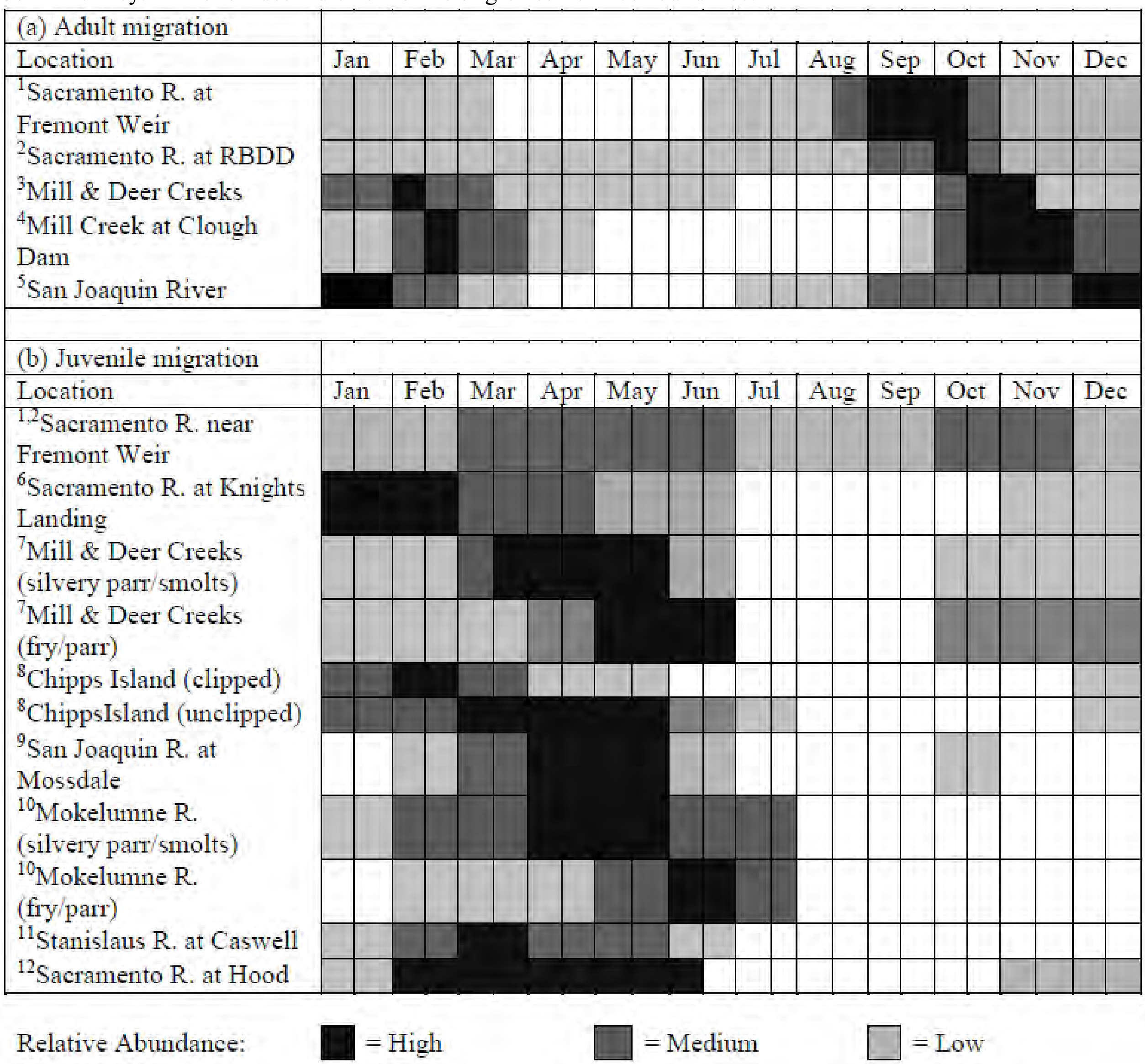
The CCV steelhead DPS is at high risk of extinction (NMFS 2011c), and the extinction risk is increasing. The most recent viability assessment of CCV steelhead was conducted during NMFS' 2011 status review (NMFS 2011c). This review found that the biological status of the ESU has worsened since the last status review recommend that its status be reassessed in two to three years as opposed to waiting another five years, if it does not respond positively to improvements in environmental conditions and management actions. Despite 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, and the presence of spawning and rearing habitat make it an important node of habitat for the survival and recovery of the species.

2.2.4.2 Distribution

CV steelhead historically were well-distributed throughout the Sacramento and San Joaquin Rivers (Busby *et al.* 1996) and were found from the upper Sacramento and Pit River systems (now inaccessable due to Shasta and Keswick Dams) south to the Kings and possibly the Kern River systems, and in both east- and west-side Sacramento River tributaries (Yoshiyama *et al.* 1996). Lindley *et al.* (2006) estimated that historically there were at least 81 independent CV steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin Rivers. This distribution has been greatly affected by dams (McEwan & Jackson 1996). Presently, impassable dams block access to 80 percent of historically available habitat, and block access to all historical spawning habitat for about 38 percent of historical populations (Lindley *et al.* 2006).

Table 5 gives the distribution and timing of CCV steelhead in the Central Valley. Note that temporal occurrence varies depending on the life stage.

Table 5. 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.



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 and 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).

2.2.4.3 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 (up to the confluence with the Merced 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 OHWL. In areas where the OHWL 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 and 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.

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. Tributaries to the Sacramento River with year-round flows have the primary spawning habitat for CCV steelhead. 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. <u>Freshwater Migration Corridors</u>

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. This PBF is outside of action area for the prosed project.

2.2.4.4 Description of VSP Parameters

2.2.4.4.1 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 1990's, 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. Redd counts are conducted in the American River, with an average of 154 redds have been counted on the American River from 2002-2010 (data from Hannon & Deason 2008, Hannon *et al.* 2003, Chase 2010).

Coleman Nation 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 Central Valley 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). Wild 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.

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. 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. However, preliminary return data for 2011(CDFG) shows a slight rebound in numbers, with 712 adults returning to the hatchery through April 5th, 2011.

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. The vast majority of these steelhead are wild fish, as no hatchery steelhead are stocked in Clear Creek.

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 2011 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.

2.2.4.4.2 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 2011c).

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 2011c). 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.

2.2.4.4.3 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.

Spatial structure for steelhead is fragmented and reduced by elimination or significant reduction of the major core populations (*i.e.,* Sacramento, Feather, American rivers) that provided a source for the numerous smaller tributary and intermittent stream populations like Dry Creek, Auburn Ravine, Yuba River, and Deer, Mill, and Antelope creeks. Tributary populations can likely never achieve the size and variability of the core populations in the long-term, generally due to the size and available resources of the tributaries. The widespread distribution of wild steelhead in the CCV provides the spatial structure necessary for the DPS to survive and avoid localized catastrophes. However, 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 (NMFS 2011c). 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.

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 2014a) includes recovery criteria for the spatial structure of the DPS which includes, 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 San Joaquin River Restoration Program (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 spring-run Chinook salmon could also benefit CCV steelhead (NMFS 2011b).

2.2.4.4.4 Diversity

a. Genetic Diversity

California Central Valley 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 Central Valley 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 CV 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, FRFH, 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).

2.2.5 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.

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

Spring-run Chinook salmon adults are vulnerable to climate change because they over-summer in freshwater streams before spawning in autumn (Thompson *et al.* 2012). 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 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 environmental baseline describes the status of listed species and critical habitat in the action area, to which we add the effects of the proposed channel rehabilitation, to consider the effects of the proposed Federal actions within the context of other factors that impact the listed species. The effects of the proposed Federal action are evaluated in the context of the aggregate effects of all factors that have contributed to the status of listed species and, for non-Federal activities in the action area, those actions that are likely to affect listed species in the future, to determine if implementation of the proposed channel rehabilitation is likely to cause an appreciable reduction in the likelihood of both survival and recovery or result in destruction or adverse modification of critical habitat.

The Sacramento River originates near Mt. Shasta, and flows south for 447 miles before reaching the Sacramento–San Joaquin River Delta and San Francisco Bay. Shasta Dam, which is located at RM 311 on the Sacramento River near Redding, California, was completed in 1945. It serves to control floodwaters and store surplus winter runoff for irrigation in the Sacramento and San Joaquin Valleys, maintain navigation flows, provide flows for the conservation of fish in the Sacramento River and water for municipal and industrial use, protect the Sacramento-San Joaquin Delta from intrusion of saline ocean water, and generate hydroelectric power. Keswick Dam (RM 302) was constructed nine miles downstream from Shasta Dam to create a 23,800 acre-foot afterbay for Shasta Lake and the Trinity River Division, which stabilizes uneven water releases from the power plants. Below Keswick Dam, the Anderson-Cottonwood Irrigation District Diversion Dam (ACID Dam; RM 297) is seasonally in place to raise the water level for diversions into the ACID canal. The 59 mile reach of the Sacramento River between Keswick Dam and RBDD is commonly referred to as the Upper Sacramento River.

Coarse sediment from the upper watershed is prevented from being transported downstream by Shasta and Keswick dams, resulting in an alluvial sediment deficit and reduction in fish habitat quality within the Upper Sacramento River reach (Wright & Schoellhamer 2004). In addition to the reduction of sediment supply, recruitment of large woody material to the river channel and floodplain has also declined due to a reduction in bank erosion and blockage of wood transport by Shasta Dam.

The combination of degraded physical habitat characteristics, fish passage barriers, and changes in hydrology resulting from dams and diversions since the mid-1800s has been associated with salmonid and green sturgeon declines within the Sacramento River watershed.

Conservation efforts along the Sacramento include the Bullock Bend Mitigation Bank, which is a 119.65-acre site in Yolo County, California. Bullock Bend has been approved by the U.S. Army Corps of Engineers, U.S. Environmental Protection Agency, U.S. Fish and Wildlife Service, California Department of Fish and Wildlife and National Oceanic Atmospheric Administration to provide credits for impacts to salmon, steelhead, Swainson's hawk, other waters of the U.S., and riparian habitat. Surrounded on three sides by the Sacramento River, restoration of the site has re-established connectivity between the river and the historic floodplain through the breach of a farm berm on the south side of the property. This has allowed the river water to naturally flood the property, creating off-channel salmonid rearing habitat. Habitat types developed at the bank include restored floodplain riparian, enhanced riparian floodplain forest, and enhanced shaded riverine aquatic habitat. The floodplain restoration and breaching of a farm berm on the property supports the objectives of the Recovery Plan for Sacramento River winter-run Chinook salmon, Central Valley spring-run Chinook salmon, and Central Valley steelhead (http://www.wesmitigation.com/cabanks/bullock-bend-mitigation-bank/ Accessed on 22 May 2017).
The action area, which encompasses the last 4 miles of Elder Creek before its confluence with the Sacramento River at RM 230, functions primarily as a rearing and migratory habitat for Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead. Due to the life history timing of winter- and spring-run Chinook salmon and steelhead, it is possible for the following life stages to be present within the action area throughout the year: rearing and emigrating juveniles.

The action area is within designated critical habitat for CV spring-run Chinook salmon and CCV steelhead, and is very near the critical habitat for Sacramento River winter-run Chinook salmon. Habitat requirements for these species are similar. The PBFs of salmonid habitat within the action area include: freshwater rearing habitat and freshwater migration corridors. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. The intended conservation roles of these habitats are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration conditions for adults.

The conservation condition and function of this habitat has been severely impaired through several factors discussed in the *Rangewide Status of the Species and Critical Habitat* section of this Opinion. The result has been the reduction in quantity and quality of several essential features of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, the intrinsic conservation value of the action area is high because the juveniles rearing in intermittent tributaries have been shown to grow faster and smolt faster and emigrate earlier than their mainstem counterparts (Maslin *et al.* 1996).

2.3.1 Hydrology

Flows in the Sacramento River in the 65 mile reach between Shasta Dam and RBDD are regulated by Shasta Dam and again, just downstream at Keswick Dam. Water stored in the reservoirs during the winter and spring is released in the summer and fall for municipal and industrial supply, irrigation, water quality, power generation, recreation, and fish and wildlife purposes. Historically, the Upper Sacramento River was highly responsive to periodic precipitation events and seasonal variation. Since completion of the dams, flows are now lower in the winter and spring and higher in the summer and fall. During July, August, and September, the mean monthly flows of the Sacramento River at Keswick since 1963 are nearly 400 percent higher than the mean monthly flows prior to 1943 (DWR 1981, as cited in the Sacramento River Conservation Area Forum [SRCAF] Handbook 2003). In this reach, flows are influenced by tributary inflow. Major west-side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood creeks. Major east-side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Payne's creeks.

2.3.2 Land Use

As reported in the SRCAF (2003), the Keswick-RBDD Reach has a variety of land uses – urban, residential, industrial, and agricultural. About 35 percent of the area is in agriculture, and about 12 percent is urban, residential, or industrial. Industrial land uses within this reach include lumber mills and gravel removal operations. Residential and commercial land uses in the cities of Redding, Anderson, and Red Bluff are common as well. In addition, this reach has the most recreational facilities on the Sacramento River (SRCAF 2003). Historically, the river between Redding and Anderson supported several gravel mining operations (SRCAF 2003).

2.3.3 Water Quality

The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of surface water downstream of Keswick Dam is also influenced by other human activities along the Sacramento River downstream of the dam, including historical mining, agricultural, and municipal and industrial activities. The quality of water in the Sacramento River is relatively good; only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski *et al.* 2000). Water quality issues within the upper Sacramento River include the presence of mercury, pesticides such as organochlorine, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000). The Central Valley Regional Water Quality Control Board (CVRWQCB) has determined that the 25-mile segment of the Upper Sacramento River between Keswick Dam and the mouth of Cottonwood Creek is impaired by levels of dissolved cadmium, copper, and zinc that periodically exceed water quality standards developed to protect aquatic life (CVRWQCB 2002). The reach is also listed under Clean Water Act (CWA) 303(d) by the CVRWQCB for unknown sources of toxicity (CVRWQCB 2007). Water temperature in the Sacramento River is controlled by releases from Shasta, Whiskeytown, and Keswick reservoirs. NMFS issued an Opinion on the long-term operation of the CVP and SWP (NMFS 2009), which included Upper Sacramento River water temperature requirements to protect listed anadromous fish and their critical habitats. However, the ability to meet temperature requirements has proven extremely difficult during drought years.

2.3.4 Predation

Sacramento pikeminnow (*Ptychocheilus grandis*) and striped bass (*Morone saxatilis*) congregate downstream of Keswick Dam and prey on juvenile salmon in the tail waters. The Sacramento pikeminnow is a species native to the Sacramento River basin and has co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (*e.g.*, warm water, low-irregular flow, standing water, and water diversions) compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker *et al.* (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow.

2.3.5 Fisheries and Aquatic Habitat

The Upper Sacramento River between Keswick Dam (RM 302) and RBDD (RM 243) currently serves as the only spawning ground for winter-run Chinook salmon, and is an important migration corridor for adult and juvenile spring-run Chinook salmon and steelhead, particularly populations from Cottonwood Creek, Clear Creek, Cow Creek and Battle Creek, as well as other smaller tributaries. Green sturgeon utilize the upper Sacramento River as a migratory corridor as well as for spawning and juvenile rearing.

Shasta and Keswick dams have presented impassable barriers to anadromous fish since 1943 (Moffett 1949 as cited in Poytress *et al.* 2014). ACID Dam and RBDD presented partial barriers to salmonid migration until improvements were made in 2001 and 2012 (NMFS 2009, 2014a), respectively, although ACID Dam continues to present an impassable barrier to green sturgeon (NMFS 2009).

2.3.6 Status of Species and Critical Habitat in the Action Area

Within California's Central Valley are four runs of Chinook salmon: winter-run, spring-run, fall-run, and late-fall run. The Sacramento River has been substantially degraded as a rearing habitat for juvenile Chinook, however, Elder Creek supports nonnatal juvenile rearing of all of these runs. While Elder Creek has the mass movement of small rock debris typical of west side tributaries, it has been artificially confined between levees which prevents lateral scour. Consequently, it has a very unstable bed, and an almost uniform flow rather than the stair-step of riffles and pools characteristic of most streams. Riparian vegetation has colonized the artificial banks, but there is little recruitment of woody debris to force the scouring of pools.

Historically, the Sacramento River had many shallow, protected backwaters and side channels characterized by slower velocities and eddies that provided ideal habitat for juvenile rearing (Thompson 1961). Unfortunately, most of this habitat has been lost due to erosion and flood control practices which have decreased the overall braiding and sinuosity of the river, decreasing total available habitat and increasing mean velocities. Flood control practices require peak flood discharges to be held back and released over a period of weeks. Flood reduction has reduced scouring of new habitats while existing ones continue to fill in (Maslin *et al.* 1996). Given the loss of over half of historically available headwater habitats due to the migration barriers of impassable dams and the reduction of both quantity and quality of the river mainstem, it is important that all remaining habitat be valued.

Maslin *et al.* (1998) conclude that it is a reasonable estimate that between 100,000 and 1 million juveniles rear non-natally in tributaries. While any one intermittent tributary may provide rearing habitat for only 5,000 to 50,000 juveniles, all the tributaries in aggregate produce many good condition smolts which, growing 2-3 times as fast, may reach smoltification age a month earlier than they would rearing in the river. A 90 mm smolt migrating down river in April has a far better chance of avoiding predators and diversions than a fry washing down-river or a smolt migrating in May (Maslin *et al.* 1996).

Researchers from California State University, Chico have consistently captured wild and hatchery origin Chinook salmon juveniles in small, intermittent tributaries of the Sacramento River where there are no records of spawning adults (Maslin *et al.* 1994, 1995, 1996, 1997, 1998, 1999). Small, intermittent tributaries have generally been overlooked and need to be considered in efforts to protect threatened and endangered salmonids. Intermittent streams contribute to the overall habitat complexity of the river system and actions may be necessary to protect them, and to ensure adequate flows and conditions for rearing. While few of these tributaries serve as spawning habitat for Chinook salmon, they provide important rearing habitat, particularly for the imperiled winter- and spring-runs (Maslin *et al.* 1995). Maslin *et al.* 1997 estimated the juvenile Chinook population present in March 1997 in Elder Creek to be 4,000 individuals, with the furthest capture 6.5 km upstream. This is a conservative estimate as intermittent streams are very difficult to sample.

Following runoff from winter storms, the mainstem is often too high, cold, and turbid to provide quality rearing habitat. Conditions in the tributaries can be more favorable with respect to temperature, food availability, water velocity, and clarity (Maslin *et al.* 1995). Small tributary creeks are generally less turbid than the mainstem Sacramento River and clear up faster after storm events. Lower turbidity in the tributaries should be advantageous to juvenile salmonids, as they are sight feeders, and even moderate levels of turbidity (*e.g.*, 24 Nephelotometric Turbidity Units [NTUs]) are known to reduce feeding efficiency (Chapman & Bjornn 1969). Stress from high sediment levels during winter and spring floods may induce juveniles to move into nonnatal tributaries in order to feed and to clear their gills of sediments (Scrivener *et al.* 1994).

In addition to escaping unfavorable environmental conditions which occur periodically in the mainstem, juvenile Chinook may migrate into the tributaries to exploit food resources (Williams 1987). Optimal rearing conditions in the tributaries exist from approximately December through March, so juvenile Chinook entering the creeks early in the year, such as winter- and spring-run, probably derive the most benefit from tributary rearing (Maslin *et al.* 1995). Fall-run, and especially late fall-run, may be exposed to warmer than optimal temperatures, predation, and stranding (Maslin *et al.* 1995). .

In other river systems, research suggests that movements of young salmonids from spawning areas to rearing areas consist of complex local migrations (upstream, downstream, or both), that are genetically and environmentally controlled (Murray & Rosenau 1989). Warmer temperatures early in the year may induce juveniles to enter tributaries, and enhance the growth of those which remain for all or part of their rearing phase (Maslin *et al.* 1995). Every small tributary of the Sacramento River sampled contained juvenile Chinook and those who entered apparently remained there for some time. This was evidenced by the distance upstream from the river where they were caught (over 22 km in some cases) and upstream juvenile size distributions varying markedly from those captured in or near the river (Maslin *et al.* 1995).

Some of the most extensive documentation and research on nonnatal rearing of juvenile Chinook salmon in intermittent tributaries of the Sacramento River has been conducted by Paul Maslin and others from California State University, Chico. Over several years, their studies have attempted to estimate the spatial and temporal extent of nonnatal rearing, as well as to calculate the race distribution, growth rates, and condition factors of juvenile Chinook rearing in tributaries. Their data suggests that juvenile Chinook rearing in the tributaries grew faster and were heavier for their age than those rearing in the mainstem. Faster growth and better condition of juvenile Chinook rearing in tributaries may be explained by several physical and biological characteristics of intermittent tributaries, including relatively warm temperatures, diel temperature fluctuations, low turbidity, and lack of established predator populations. Faster growing fish smolt earlier, and may enter the Delta earlier in the year, before low water and pumping degrade rearing habitat (Maslin *et al.* 1995).

Because they are dry for months at a time, intermittent tributaries lack resident populations of large, piscivorous fishes. This is an obvious advantage to juvenile salmonids as if less energy is expended on predator avoidance, more will be available for feeding and growth (Maslin *et al.* 1995). However, later in the season (usually in April), adult squawfish move into the tributaries to spawn, and may prey on juvenile Chinook. Interface predators, such as mergansers, egrets, herons, otters, and raccoons prey on fishes in the shallow water of receding streams. Juvenile Chinooks which enter intermittent streams early (winter- and spring-run) and smolt before water levels recede have a better chance of avoiding predators (Maslin *et al.* 1995).

In attempts to quantify the prey items and conditions of juvenile Chinook, benthic invertebrates were sampled in a number of intermittent tributaries. Collections of benthic invertebrates in Mud, Blue Tent and Dibble Creek contained an abundance of midges, mayflies, and stoneflies. Stomach contents of juvenile chinook from tributaries in 1995 and 1996 were compared with those reported for juveniles collected from the Sacramento River (Schaffter *et al.* 1982). An average of 41 food items per stomach in the tributary samples compares favorably with an average of 22 food items per stomach reported for Sacramento River juveniles (Maslin *et al.* 1996).

2.3.6.1 Sacramento River Winter-run Chinook salmon

The distribution of Sacramento River winter-run Chinook salmon spawning and rearing is currently limited to the upper Sacramento River, with managed flows out of Shasta Dam. Keswick Dam re-regulates flows from Shasta Dam and mixes it with water diverted from the Trinity River through the Spring Creek tunnel to control water temperatures below ACID pursuant to actions in the NMFS Opinion, to provide cold water throughout the summer, allowing for spawning, egg incubation, and rearing during the mid-summer period (NMFS 2009). Approximately, 299 miles of tributary spawning habitat in the upper Sacramento River above the dams is now inaccessible to winter-run (NMFS 2014a).

The proportion of the winter-run Chinook salmon spawning above ACID has increased since the ladder improvements in 2001. Although variable, between 2002 and 2014, an average of 45 percent spawn between Keswick Dam and ACID Dam, and the last three years, an average of 66 percent (CDFW 2014 unpublished aerial redd counts). Data on the temporal distribution of winter-run Chinook salmon upstream migration suggest that in wet years about 50 percent of the run has passed the RBDD by March, and in dry years, migration is typically earlier, with about 72 percent of the run having passed the RBDD by March (Poytress *et al.* 2014).

The upper Sacramento River contains the only remaining habitat that is currently used by spawning Sacramento River winter-run Chinook salmon. As reported by NMFS (2014a), historical winter-run population estimates, were as high as over 230,000 adults in 1969, but declined to under 200 fish in the 1990s (Good *et al.* 2005). A rapid decline occurred from 1969 to 1979 after completion of the RBDD. Over the next 20 years, the population eventually reached a low point of only 186 adults in 1994. At that point, winter-run Chinook salmon were at a high risk of extinction, as defined by Lindley *et al.* (2007). However, several conservation actions, including a very successful conservation hatchery and captive broodstock program at LSNFH, construction of a temperature control device (TCD) on Shasta Dam, maintaining the RBDD gates up for much of the year, and restrictions in ocean harvest, have likely prevented the extinction of natural-origin winter-run Chinook salmon. LSNFH, which is located at the base of Keswick Dam, annually supplements the in-river production by releasing on average 180,000 winter-run smolts into the upper Sacramento River. The LSNFH operates under strict guidelines for propagation that includes genetic testing of each pair of adults and spawning no more than 10 percent of the hatchery returns. This program and the captive broodstock program (phased out in 2007) were instrumental in stabilizing the winter-run Chinook population following very low returns in the 1990s.

More recently, since carcass surveys began in 2001, the highest adult escapement occurred in 2005 and 2006 with 15,839 and 17,296, respectively. However, from 2007 to 2012, the population has shown a precipitous decline, averaging 2,486 during this period, with a low of 827 adults in 2011. This recent declining trend is likely due to a combination of factors such as poor ocean productivity (Lindley *et al.* 2009), drought conditions from 2007-2009, and low in-river survival (NMFS 2011a). In 2013, the population increased to 6,075 adults, and in 2014, 3,015, which are both well above the 2007–2012 average, but below the high for the last ten years.

2014 was the third year of a drought which increased water temperatures in the upper Sacramento River. This caused significantly higher mortality (95-97%) in the upper spawning area. Due to the expected lower than average survival in 2014, hatchery production from the LSNFH conservation program was tripled to offset the impact on the naturally spawning fish. Normally LSNFH produced an average of 176,348 fish per year, with in-river natural production resulting in an average of 4.7 million. In 2014, hatchery production represented 50-60% of the total in-river juvenile production, compared to 3 to 4 percent on average in a normal year.

2.3.6.2 Central Valley Spring-run Chinook Salmon

CV spring-run Chinook salmon were impacted by a number of past human activities. 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.

The status of the spring-run population within the mainstem Sacramento River above RBDD appears to have declined from a high of 25,000 in the 1970s to an average low of less than 800 counted at RBDD beginning in 1991. Significant hybridization with fall-run has made identification of a spring-run population in the mainstem very difficult to determine, and there is speculation as to whether a true spring-run population still exists below Keswick Dam. This shift may have been an artifact of the manner in which spring-run were identified at RBDD. More recently, fewer spring-run were counted at RBDD because an arbitrary date, September 1, was used to determine spring-run, and gates are now (beginning in 2012) open year round (NMFS 2014a).

The extent of non-hybridized spring-run spawning in the Sacramento River mainstem is unknown. However, the physical habitat conditions below Keswick Dam is capable of supporting spring-run, although in some years high water temperatures can result in substantial levels of egg mortality. Current redd surveys (2001-2014 – update?) have observed an average of 41 salmon redds in September, from Keswick Dam downstream to the RBDD, ranging from zero to 105 redds (CDFG, unpublished data, 2015). This is typically when spring-run spawn, however, there is no peak that can be separated out from fall-run spawning, so these redds also could be early spawning fall-run. Additionally, even though habitat conditions may be suitable for spring-run occupancy, 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 to have caused extensive introgression between the populations (CDFW 1998).

2.3.6.3 CCV 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. CCV steelhead have similar spawning and rearing preferences as CV spring-run Chinook salmon, as 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).

Estimates of CCV steelhead abundance in the mainstem Sacramento River typically use the RBDD counts for historical trend data. Since the RBDD gates started operation in 1967, the CCV steelhead abundance in the upper Sacramento River has declined from 20,000 to less than 1,200 on average beginning in 1992. Beginning in 1991, the RBDD gates have been opened after September 15, making estimates of CCV steelhead pass RBDD unreliable. CCV steelhead passage above RBDD after 1991 can be estimated based on the average of the 3 largest tributaries (Battle Creek, Clear Creek and Cottonwood Creek). The average of these tributaries for 1992 through 2005 was 1,282 adults, which represents a continuous decline from the 1967 through 1991 average RBDD count of 6,574. Actual estimates of CCV steelhead spawning in the mainstem Sacramento River below Keswick Dam have never been made due to high flows and poor visibility during the winter time.

2.4 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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead, and the magnitude, timing, frequency, and duration of project impacts to these listed species. Due to the life history timing of winter- and spring-run Chinook salmon and steelhead, it is possible for the following life stages to be present within the action area when the creek channel is wetted: rearing and emigrating juveniles.

The PBFs of critical salmonid habitat within the action area that may be impacted by the proposed action are freshwater rearing habitat and freshwater migration corridors for juveniles. The essential features of these PBFs include adequate substrate, water quality, water quantity, water temperature, water velocity, shelter, food, riparian vegetation, space, and safe passage conditions. Elder Creek provides intermittent freshwater rearing sites to support enhanced juvenile growth and mobility. During periods of heavy runoff following winter storms conditions in intermittent tributaries can be more favorable than the mainstem in terms of water quality (*e.g.*, temperature, velocity, clarity) and forage availability to support juvenile salmonid development.

To evaluate the effects of the Elder Creek Channel Rehabilitation 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 the DWR's proposed conservation and mitigation measures. Specifically, the assessment will consider the potential impacts related to these species resulting from the Elder Creek Channel Rehabilitation Project, including: 1) construction impact analysis, 2) hazardous materials entering the water, 3) increased turbidity, 4) loss of SRA cover and riparian vegetation, and 5) purchase of advance mitigation credits. Additionally, the assessment will consider the potential impacts to critical habitat and beneficial effects of improved riverine connection, channel capacity, and invasive plant removal. Long-term O&M is not being proposed as part of this project. This assessment relied heavily on the information from DWR's BA project description, site visits, and in depth discussions with consulting biologists and project engineers.

2.4.1 Construction Impact Analysis

Given that Elder Creek is an intermittent tributary, NMFS does not expect that juvenile winter-run and spring-run Chinook salmon or CCV steelhead will be present in the action area because construction is scheduled to take place only when the active channel is dry (*i.e.*, creek is not running). Therefore, there will be no direct impacts to fish species during construction activities. If there are pools or ponded areas remaining in the channel, DWR has committed to excluding work areas of potential habitat. These areas will be avoided until the channel completely dries to avoid direct impact to listed fishes. Additionally, all finish grading within the channel will be conducted in a manner which will avoid and/or minimize the potential for pools or depressions to form the following wet season and increase the potential for fish stranding.

The current sediment accumulation (mainly fine sands) in the levee section of Elder Creek does not allow for the creation of stable pool/riffle complex with courser sediment (*i.e.*, cobble and gravels) which stream rearing juvenile fish may benefit from. This accumulated sediment has decreased the capacity and flow conveyance of the channel. A sediment trap in the lower most reach of the channel has resulted in a plug that reduces frequency of connectivity with the Sacramento River. Additionally, the excess sediment has increased the area for giant reed to establish, which has increased water intake for this highly invasive species. The removal of sediment will increase frequency and duration of flow and connectivity to the Sacramento River which will have a beneficial effect on juvenile rearing fish as it will create more of a backwater effect further up the stream. The removal of sediments will also help to increase the habitat complexity of the channel and potentially decrease the rate at which arundo can establish, both of which will benefit to rearing juvenile salmonids.

2.4.2 Hazardous Materials

The potential spill of hazardous materials (*e.g.*, fuel, lubricants, hydraulic fluid) during construction and staging activities into the upper Sacramento River could have deleterious effects on juvenile and adult winter-run Chinook salmon, spring-run Chinook salmon, steelhead, and their prey. Additionally, 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). Petroleum products also tend to form oily films on the water surface that can reduce dissolved oxygen (DO) levels available to aquatic organisms.

NMFS expects that adherence to BMPs that dictate the use, containment, and cleanup of contaminants will minimize the risk of introducing such products to the waterway. DWR will adhere to requirements of a Construction General Permit from the SWRCB prior to initiating earth disturbing activities. Among other things, the conditions of the Permit will include the development and implementation of a SWPPP with BMPs and an HMMP. Compliance with the Construction General Permit, including the 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.

DWR will develop and implement a spill prevention, control, and counter-measure plan (SPCCP) prior to the onset of construction. The SPCCP will include measures to be implemented onsite that will keep construction and hazardous materials out of waterways and drainages. The SPCCP will include provisions for daily checks for leaks; hand-removal of external oil and grease. In addition, all construction equipment refueling and maintenance will be restricted to designated staging areas located away from the river channel and sensitive habitats. 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 winter-run and spring-run Chinook salmon and steelhead.

2.4.3 Increased Turbidity

The re-suspension and deposition of instream sediments is an indirect effect of construction equipment and gravel entering Elder Creek and the Sacramento River. 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, and avoidance) to sublethal effects (*e.g.*, reduced feeding rate), and, at high suspended sediment concentrations for prolonged periods, lethal effects (Newcombe & Jensen 1996).

Silt and sand on the creek bottom will be disturbed in the action area during excavation and removal of materials despite construction only occurring when the channel is dry. Suspension of disturbed sediment during the onset of the following wet season will occur, however, most re-suspension and re-deposition of instream sediments is expected to be localized and occur prior to juveniles entering the creek channel to rear. Development and implementation of a SWPPP with BMPs for construction activities would reduce potential impacts to listed fishes and other aquatic species and habitat resulting from sedimentation and turbidity. Therefore, the impacts of increased turbidity are considered temporary and will not reach a level that cause and adverse effect to any life stages of winter-run and spring-run Chinook salmon and steelhead.

2.4.4 Loss of SRA Cover and Riparian Vegetation

Complex natural banks are generally characterized by rich habitat diversity with variable water depths and velocities, including shallow, low-velocity areas used by juveniles as refuge from fast currents and predators. SRA cover is the nearshore aquatic area occurring at the interface between a river and adjacent woody riparian habitat. The principal attributes of SRA include natural, eroding substrates supporting riparian vegetation that either overhangs or protrudes into the water, and the water containing variable amounts of woody debris, such as leaves, logs, branches and roots. Large woody material and instream woody debris provide important sources of cover and food for juvenile fishes and other aquatic organisms. In addition to cover and shelter for fish, riparian vegetation provides other important stream ecosystem functions, including channel and streambank stability; inputs of food (*e.g.*, terrestrial insects), organic material, and nutrients; and temperature moderation (Murphy & Meehan 1991).

SRA, particularly the riparian vegetation component, is important for rearing and out-migrating juvenile salmon because it provides overhead and instream cover from predation and enhances food production. Terrestrial insects and LWM that fall from riparian plants into the river enhance the aquatic food webs and provide high-value feeding areas for juvenile salmonids. Once in the river channel, the stems, trunks, and branches become very important structural habitat components for aquatic life. Many of the aquatic invertebrates that are primary food sources for juvenile salmon and steelhead live on woody debris. In some cases, the reproductive cycles of macroinvertebrates are tied to LWM, as their eggs are laid and develop inside fallen logs and are eventually eaten by fishes.

Riparian shade can be critical in preventing diurnal thermal maxima from reaching dangerous levels, thereby extending the usable season for these small streams (Maslin *et al.* 1997). Trees and shrubs growing along river banks providing microclimates of cooler water temperatures during the hot summer months where many fishes will congregate to feed and seek cover. In addition, the roots, branches and other submerged plant materials provide cover for young fishes, as well as nutrients and sources of invertebrates. Riparian trees and shrubs will eventually end up in the river channel as floods erode the bank or sweep them from the floodplain. LWM 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.

Rearing habitat is available, but somewhat limited, within the action area reach of Elder Creek. The active channel is a mobile sand bed that is confined by the levee on both banks. Implementing the project may affect freshwater rearing sites because riparian vegetation will be trimmed and removed throughout the channel which provides natural cover and supports juvenile growth and mobility. However, because the location of riparian vegetation is variable throughout the channel reach in relation to the active stream and pooled areas where juvenile fish may occur, this impact would not adversely impact the habitat stability. The majority of riparian vegetation impacted will be sparse scrub shrub on elevated sand bars away the main thalweg (*i.e.*, active channel). Vegetation removal will not permanently impact habitat stability because the riparian vegetation to be removed re-establishes rapidly in these areas the areas where juvenile fish may likely occur. Riparian scrub shrub (mainly willows) on unstable sand bars that erode frequently will be allowed to recolonize. Additionally, all large instream woody structures that do not impede the flow will be kept to increase the complexity of the channel.

Results from multiple hydraulic modeling scenarios conducted by DWR for Elder Creek originally called for the removal of approximately 26 acres of giant reed, 21 acres of miscellaneous riparian vegetation (clearing of vegetation ≤ 4 inches in diameter), 308 elderberry shrubs, and 150,000 cubic yards of sediment. In an effort to minimize the environmental impacts (*i.e.*, removal of elderberry shrubs, riparian vegetation), additional hydraulic analyses were performed on the channel. As a result of the analyses, DWR found a scenario that met the hydraulic design guidelines of the channel while greatly reducing the impacts to the surrounding native vegetation. These impacts were reduced to in order to align the Proposed Action to DWR's Central Valley Flood Protection Plan (CVFPP) Conservation Framework, which focuses on promoting ecosystem functions and multi-benefit projects, identifies opportunities for integrated flood management projects that can, in addition to improving public safety, enhance riparian habitats, provide connectivity of habitats, restore riparian corridors, improve fish passage, and reconnect the river and floodplain.

The new scenario consists of removing all giant reed, 4.05 acres of miscellaneous riparian vegetation, 1.78 acres of elderberry shrubs (approximately 18 shrubs), and 100,000 cubic yards of sediment from the channel. In addition, approximately 1.4 acres of mature riparian would be trimmed/limbed. The new scenario greatly reduced impacts to elderberry shrubs and riparian vegetation. Riparian vegetation to be removed was greatly reduced from 21 acres to 4.05 acres, which will save approximately 17 acres of mature riparian vegetation. For the four combined mile-long project sites along Elder Creek, riparian vegetation losses will total approximately 4.05 acres. Short-term impacts of vegetation removal could last from several to 10 years following the completion of the project at year 5. This loss is expected to be short-term as recolonization in and along the channel will not be suppressed by future maintenance activities.

2.4.5 Advanced Mitigation Credit Purchase

To provide compensatory mitigation for the unavoidable adverse impacts to listed fish species and associated critical habitat from the removal of riparian habitat, advance mitigation credits will be purchased at the Bullock Bend Mitigation Bank at a 3:1 ratio. The specific type of credit that will be purchased are restored and enhanced salmonid/riverine and salmonid/floodplain habitat credits.

2.5 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.

2.5.1 *Water Diversions and Agricultural Practices*

Non-Federal actions that may affect the action area include the town of Gerber and Los Flores, water diversions for irrigated agriculture, ongoing agricultural activities, and municipal and industrial use along the Elder Creek action area. Agricultural practices in and upstream of the Elder Creek may adversely affect riparian and floodplain habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow in runoff flowing into the Elder Creek stream channel. Unscreened or improperly screened agricultural diversions throughout the channel may entrain fish including juvenile salmonids. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species. 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).

Increased water turbidity levels for prolonged periods of time may result from agricultural practices, could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile Chinook or steelhead in the vicinity and downstream of the project area. High turbidity concentration can cause fish mortality, reduce fish feeding efficiency and decrease food availability (Berg & Northcote 1985). Farming and ranching activities within or adjacent to the action area may have negative effects on water quality due to runoff laden with agricultural chemicals. Stormwater and irrigation discharges 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.

2.5.2 *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).

2.5.3 Increased Urbanization

Future urban 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 which are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA Section 7 consultation process with NMFS.

2.5.4 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 +2º C and +7º C by 2100 (Dettinger *et al.* 2004; Hayhoe *et al.* 2004; Van Rheenen *et al.* 2004; Stewart 2005), 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 fish within the action area that are the subject of this consultation.

2.6 Integration and Synthesis

The *Integration and Synthesis* section is the final step of NMFS' assessment of the risk posed to species and critical habitat as a result of the proposed action. In this section, NMFS performs two evaluations: whether, given the environmental baseline and status of the species and critical habitat, as well as future cumulative effects, it is reasonable to expect the proposed action is not likely to (1) reduce the likelihood of both survival and recovery of the species in the wild, and (2) result in the destruction or adverse modification of designated critical habitat (as determined by whether the critical habitat will remain functional to serve the intended conservation role for the listed anadromous species or retain its current ability to establish those features and functions essential to the conservation of the species).

The *Analytical Approach* described the analyses and tools we have used to complete this analysis. This section is based on analyses provided in the *Status of the Species*, the *Environmental Baseline*, and the *Effects of the Proposed Action*.

In our *Status of the Species* section, NMFS summarized the current likelihood of extinction of each of the listed species. We described the factors that have led to the current listing of each species under the ESA across their ranges. These factors include past and present human activities and climatological trends and ocean conditions that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover. The *Environmental Baseline* reviewed the status of the species and the factors that are affecting their survival and recovery in the action area. The *Effects of the Proposed Action* reviewed the exposure of the species and critical habitat to the proposed action, interrelated and interdependent actions, and cumulative effects. NMFS then evaluated the likely responses of individuals, populations, and critical habitat. The *Integration and Synthesis* will consider all of these factors to determine the proposed action's influence on the likelihood of both the survival and recovery of the species, and on the conservation value of designated critical habitat.

The criteria recommended for low risk of extinction for Pacific salmonids are intended to represent a species and populations that are able to respond to environmental changes and withstand adverse environmental conditions. Thus, when our assessments indicate that a species or population has a moderate or high likelihood of extinction, we also understand that future adverse environmental changes could have significant consequences on the ability of the species to survive and recover. Also, it is important to note that an assessment of a species having a moderate or high likelihood of extinction does not mean that the species has little or no chance to survive and recover, but that the species faces moderate to high risks from various processes that can drive a species to extinction. With this understanding of both the current likelihood of extinction of the species and the potential future consequences for species survival and recovery, NMFS will analyze whether the effects of the proposed action are likely to in some way increase the extinction risk each of the species faces.

In order to estimate the risk to Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead as a result of the proposed action, NMFS uses a hierarchical approach. The condition of the ESU or DPS is reiterated from the *Status of the Species* section of this Opinion. We then consider how the status of populations in the action area, as described in the *Environmental Baseline*, is affected by the proposed action. Effects on individuals is summarized and the consequence of those effects is applied to establish risk to the diversity group, ESU, or DPS.

In designating critical habitat, NMFS considers the PBFs within the designated areas that are essential to the conservation of the species and that may require special management considerations or protection. Such requirements of the species include, but are not limited to (1) space for individual and population growth, and for normal behavior, (2) food, water, air, light, minerals, or other nutritional or physiological requirements, (3) cover or shelter; (4) sites for breeding, reproduction, or rearing offspring, and (5) habitats that are protected from disturbance or are representative of the historic geographical and ecological distributions of this species (see 50 CFR § § 424.12[b]). In addition to these factors, NMFS also focuses on the PBFs within the defined area that are essential to the conservation of the species. PBFs may include, but are not limited to, spawning sites, food resources, water quality and quantity, and riparian vegetation. The basis of the "destruction or adverse modification" analysis is to evaluate whether the proposed action results in negative changes in the function and role of the critical habitat in the conservation of the species. As a result, NMFS bases the critical habitat analysis on the affected areas and functions of critical habitat essential to the conservation of the species, and not on how individuals of the species will respond to changes in habitat quantity and quality.

2.6.1 Summary of Status of the Species and Environmental Baseline

2.6.1.1 Status of the Sacramento River Winter-run Chinook Salmon ESU

The most recent biological information suggests that the extinction risk of this ESU has increased since the last status review largely due to extreme drought and poor ocean conditions. The best available information on the biological status of the ESU and new threats to the ESU indicate that its ESA classification as an endangered species is appropriate and should be maintained. Long-term recovery of this ESU will require improved freshwater habitat conditions, abatement of a wide range of threats, and the establishment of additional spawning areas in Battle Creek and the McCloud River (NMFS 2016a).

2.6.1.2 Status of the CV Spring-run Chinook Salmon ESU

In the 2016 status review, NMFS found, with a few exceptions, CV spring-run Chinook salmon populations have increased through 2014 returns since the last status review (2010/2011), which has moved the Mill and Deer creek populations from the high extinction risk category, to moderate, and Butte Creek has remained in the low risk of extinction category. Additionally, the Battle Creek and Clear Creek populations have continued to show stable or increasing numbers the last five years, putting them at moderate risk of extinction based on abundance. Overall, the SWFSC concluded in their viability report that the status of CV spring-run Chinook salmon (through 2014) has probably improved since the 2010/2011 status review and that the ESU's extinction risk may have decreased, however the ESU is still facing significant extinction risk, and that risk is likely to increase over at least the next few years as the full effects of the recent drought are realized (NMFS 2016b).

2.6.1.3 Summary of the Status of the CCV Steelhead DPS

The 2016 status review (NMFS 2016c) concluded that overall, the status of CCV steelhead appears to have changed little since the 2011 status review when the Technical Recovery Team concluded that the DPS was in danger of extinction. Further, there is still a general lack of data on the status of wild populations. There are some encouraging signs, as several hatcheries in the Central Valley have experienced increased returns of steelhead over the last few years. There has also been a slight increase in the percentage of wild steelhead in salvage at the south Delta fish facilities, and the percentage of wild fish in those data remains much higher than at Chipps Island. The new video counts at Ward Dam show that Mill Creek likely supports one of the best wild steelhead populations in the Central Valley, though at much reduced levels from the 1950's and 60's. Restoration and dam removal efforts in Clear Creek continue to benefit CCV steelhead. However, the catch of unmarked (wild) steelhead at Chipps Island is still less than 5 percent of the total smolt catch, which indicates that natural production of steelhead throughout the Central Valley remains at very low levels. Despite the positive trend on Clear Creek and encouraging signs from Mill Creek, all other concerns raised in the previous status review remain.

2.6.2 Status of the Environmental Baseline and Cumulative Effects in the Action Area

The Sacramento Valley floor reach of Elder Creek supports a moderately diverse population of native and non-native fish species. Sampling for fish populations has been conducted by CSU Chico, including at sampling locations within the Action Area. Results of fishery sampling within Elder Creek have shown that at least nine fish species inhabit the creek, at least on a seasonal basis; these species include steelhead, Chinook salmon (*e.g.*, fall-, late-fall-, and spring-run), hardhead (*Mylopharodon conocephalus*), and pikeminnow (*Ptychocheilus grandis*) (Maslin *et al.* 1997). The low abundance of non-native species is atypical of the fresh waters of California but can probably be attributed to the flashy, ephemeral nature of the flow regime (Moyle *et al.* 1996). Within Elder Creek, nonnatal rearing Chinook salmon have been recorded consistently at low densities throughout the lower reach (Maslin *et al.* 1999). The action area is used by most diversity groups and populations of salmon and steelhead ESUs and DPSs that are the subject of this Opinion. Currently, listed juvenile salmonids enter the Elder Creek under certain flow conditions when it is connected to the mainstem Sacramento River and use the tributary for nonnatal rearing.

On the lower Sacramento River, near the Bullock Bend mitigation bank, the essential features of freshwater rearing for salmon and steelhead have been transformed from a meandering waterway lined with a dense riparian vegetation, to a more constrained and leveed system with limited beneficial riverine erosional processes and flooding. Levees have been constructed near the edge of the river and most floodplains have been completely separated and isolated from the Sacramento River. Severe long-term riparian vegetation losses have occurred in this part of the Sacramento River, and there are large open gaps without the presence of these essential features due to the high amount of riprap. The change in the ecosystem as a result of halting the lateral migration of the river channel, the loss of floodplains, the removal of riparian vegetation and IWM have likely affected the functional ecological processes that are essential for growth and survival of salmon and steelhead in the action area.

The *Cumulative Effects* section of this Opinion describe how continuing or future effects such as non-Federal water diversions, the discharge of point and non-point source chemical contaminant discharges, and climate change affect the species in the action area. These actions typically result in habitat fragmentation, and conversion of complex nearshore aquatic habitat to simplified habitats that incrementally reduces the carrying capacity of the rearing and migratory corridors.

2.6.3 Summary

Construction activities associated with the Elder Creek Channel Rehabilitation Project have a low probability of negatively affecting listed species given that excavation actions will occur in the dry, when fishes are not present. Effects of hazardous materials entering the waterway or increases in suspended sediment and turbidity will be further minimized to insignificant levels through the implementation of SWPPP with appropriate BMPs and an HMMP. The loss of 4.05 acres of riparian vegetation is the primary impact to listed species. Loss of SRA cover within the channel of Elder Creek could have a negative impact on rearing and out-migrating juvenile salmonids by reducing the amount of overhead and instream cover, exposing juveniles to increased predation and decreased food production in localized areas of the channel. As much of the riparian vegetation to be removed during the project is not adjacent to main thalweg of Elder Creek, the loss will not have the same impact as it would if the vegetation were contiguous along its length. Additionally, recolonization of riparian vegetation in and along the channel is fairly rapid and will not be suppressed by future maintenance activities. In summary, tthe effects of these deficits, when added to the environmental baseline and cumulative effects in the action area are relatively small.

As compensatory mitigation for unavoidable adverse effects to species and critical habitat caused by the Elder Creek Channel Rehabilitation Project, DWR will purchase advance mitigation credits (*i.e.*, prior to the start of construction) at the NMFS-approved Bullock Bend Mitigation Bank. The credit purchase shall be at a 3:1 ratio of the total acreage of riparian habitat lost onsite. After applying the mitigation ratio, a total of 12.15 credits or restored and enhanced salmonid/riverine and salmonid/floodplain habitat will be purchased. This advance mitigation measure will provide beneficial effects to salmon and steelhead through restoration measures that increase floodplain rearing habitat on the lower Sacramento River. The loss of floodplain habitat along the lower Sacramento River is a very highly ranked threat to salmon and steelhead in the NMFS Central Valley Salmon and Steelhead Recovery Plan (NMFS 2014) and restoring floodplains in this reach of the river is a priority 1 action.

Although there will be adverse impacts that reduce the quality of rearing habitat on Elder Creek, the improvements to floodplain rearing habitat at the Bullock Bend implement a high priority recovery action for all of the species impacted by the project and will substantially improve the rearing habitat for the affected ESUs and DPSs. Because of this, the project is not expected to increase the extinction risk of Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, or CCV steelhead, or reduce the conservation value of their designated critical habitat.

2.7 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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, or CCV steelhead, or destroy or adversely modify their respective designated critical habitats.

2.8 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.

The measures described below are non-discretionary, and must be undertaken by the Corps so that they become binding conditions of any grant, contract or permit, as appropriate, for the exemption in Section 7(o)(2) to apply. The Corps has a continuing duty to regulate the activity covered by this ITS. If the Corps (1) fails to assume and implement the terms and conditions, or (2) fails to require the permittee, contractor, or grantee to adhere to the terms and conditions of the ITS through enforceable terms that are added to the permit, contract or grant document, the protective coverage of Section 7(o)(2) may lapse. In order to monitor the impact of incidental take, DWR must report the progress of the action and its impact on the species to NMFS as specified in the ITS (50 CFR § §402.14(i)(3)).

2.8.1 Amount or Extent of Take

NMFS anticipates incidental take of listed juvenile listed Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead in the action area through the implementation of the Elder Creek Channel Rehabilitation Project.

NMFS cannot, using the best available information, quantify the anticipated incidental take of individual winter-run Chinook salmon, spring-run Chinook salmon, and steelhead because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use of the project area. However, it is possible to designate as ecological surrogates, those elements of the project that are expected to result in take, that are also somewhat predictable and/or measurable, with the ability to monitor those surrogates to determine the level of take that is occurring. The amount and extent of take described below is in the form of harm due to habitat impacts that will reduce the growth and survival of individuals from predation, or by causing fish to relocate and rear in other locations and reduce the carrying capacity of the existing habitat. The most appropriate threshold for take, is an ecological surrogate of temporary habitat disturbance during the channel excavation, riparian habitat loss (*i.e.*, riparian forest, scrub shrub, and SRA cover), and project site maintenance.

NMFS anticipates annual take will be limited to:

1. Take in the form of harm to rearing juvenile winter-run and spring-run Chinook salmon, and CV steelhead from the loss of up to 4.05 acres of mature riparian forest, riparian scrub shrub, and SRA cover removed during the five-year project implementation. Take will be in the form of harm to the species through modification or degradation of the PBFs for rearing and migration that reduces the carrying capacity of habitat. Take from the loss of riparian habitat (expand on PBFs) for a period of up of 10 years, may cause a behavior modification of juvenile fish avoiding the disturbed areas and having reduced growth and survival, or the loss may cause reduced food and cover, which may result in increased competition and increased risk of predation.

2. Take in the form of harm to rearing juvenile winter-run and spring-run Chinook salmon, and CV steelhead from construction activities including removal of 100,000 cubic feet of sediment, the potential for hazardous materials to enter the water, and potential for increased turbidity during the subsequent rainy seasons. Take from these activities is expected to harm the species by temporarily modifying important elements of rearing habitat. Juvenile winter-run and spring-run Chinook salmon, and steelhead will be affected because rearing and migration habitat will be temporarily disrupted. Disruption of habitat utilization may cause fish migration to be delayed or to be displaced, which may result in increased predation risk, decreased feeding, and increased competition. The behavioral modifications that result from the habitat modification are the ecological surrogates for take.

2.8.2 Effect of the Take

In this 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 Sacramento River winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead or destruction or adverse modification of their critical habitats.

2.8.3 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. The Corps shall require that DWR ensure impacts from the sites to be implemented each year are within the parameters of the Opinion. Uncertainties regarding which sites will be implemented each year could lead to impacts not analyzed.

2. The Corps shall require that DWR minimize impacts to listed species.

3. The Corps shall require that DWR minimize impacts to riparian vegetation.

4. The Corps shall require that DWR take measures to insure that DWR yard maintenance workers, contractors, and all other parties involved with these projects implement the best management practices as detailed in the BA and this Opinion.

2.8.4 Terms and Conditions

The terms and conditions described below are non-discretionary, and the Corps or any applicant (DWR) 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 Corps shall require that DWR ensure impacts from the sites to be implemented each year are within the parameters of the Opinion. Uncertainties regarding which sites will be implemented each year could lead to impacts not analyzed.

    a. The Corps shall require that DWR continue to coordinate with the NMFS during the implementation and monitoring of this channel rehabilitation project as necessary by providing updates on progress and status.

2. The Corps shall require that DWR minimize impacts to listed species.

    a. DWR shall only schedule construction when the channel is dry. DWR shall exclude work areas of potential habitat to avoid direct impact to listed fishes. Exclusion areas include wetted channel and occurrence of ponded waters (pools) with fishes. These areas will be avoided until the channel completely dries and fishes are no longer present.

    b. DWR shall finish grading within the channel in a manner that minimizes the potential for depressions to form the following wet season, thereby minimizing the potential for fish stranding.

3. The Corps shall require that DWR minimize impacts to riparian vegetation.

    a. The Corps shall require that DWR minimize the removal of existing riparian vegetation and IWM to the maximum extent practicable.

b. Prior to the start of construction, the Corps shall require that DWR provide certification that a minimum of 12.15 salmonid/floodplain enhancement/creation credits have been purchased.

c. If future maintenance actions carried out pursuant to the proposed action result in any removal of riparian vegetation or result in any degradation of floodplain habitat, the Corps shall require that DWR purchase additional credits at a 3:1 ratio to the spatial impact.

4. The Corps shall require that DWR take measures to insure that DWR yard maintenance workers, contractors, and all other parties involved with these projects implement the best management practices as detailed in the BA and this Opinion.

    a. The Corps shall require that DWR provide a copy of this Opinion to the Sutter Yard maintenance crew, making them responsible for implementing all requirements and obligations included in these documents and to educate and inform 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 will be provided to the reporting address below.

Updates and reports required by these terms and conditions shall be submitted to:

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

2.9 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 DWR should minimize any potential take whenever possible, and implement practices that avoid or minimize negative impacts to salmon, steelhead, and sturgeon and their critical habitat.

2. The Corps and DWR should support and promote aquatic and riparian habitat restoration within tributaries to the Sacramento 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 DWR should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support salmonid habitat restoration projects.

4. The Corps and DWR should make set-back levees integral components of their authorized bank protection or ecosystem restoration efforts where possible.

5. NMFS recommends that Action Agencies use species recovery plans to help ensure that their actions will address the underlying processes that limit fish recovery, and to identify key actions in the action area when prioritizing project sites each year. The final recovery plan for Central Valley listed salmonids is available at:

   http://www.westcoast.fisheries.noaa.gov/protected_species/salmon_steelhead/recovery_planning_and_implementation/california_central_valley/california_central_valley_recovery_plan_documents.html

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.

2.10 Reinitiation of Consultation

This concludes formal consultation for the Elder Creek Channel Rehabilitation 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 1999) contained in the fishery management plans developed by the Pacific Fishery Management Council and approved by the Secretary of Commerce.

3.1 Essential Fish Habitat Affected by the Project

EFH designated under the Pacific Coast Salmon Fisheries Management Plan (FMP) may be affected by the proposed action. Additional species that utilize EFH designated under this FMP within the action area include fall-run/late fall-run Chinook salmon. EFH in the action area consists of adult migration habitat and juvenile rearing and migration habitat for the four salmon runs (winter-, 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 – although degraded from historical conditions, and (2) Thermal Refugia – the Upper Sacramento River is dependent on cold water releases from Shasta and Keswick dams for listed anadromous fish. The other three HAPCs for Pacific 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

While the ESA portion of this document determined that impacts to riparian vegetation, water quality, and migration delays were either discountable or insignificant to pacific salmon, we conclude that aspects of the proposed action would adversely affect EFH for these species. Effects to the HAPCs listed in Section 3.1 are discussed in context of effects to critical habitat PBFs as designated under the ESA in Section 2.2 and subsections. Effects to ESA-listed critical habitat and EFH HAPCs are appreciably similar, therefore no additional discussion is included. A list of temporary and permanent adverse effects to EFH HAPCs is included in this EFH consultation. Affected HAPCs are indicated by number, corresponding to the list in Section 3.1:

<u>Sedimentation and Turbidity</u>

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

<u>Contaminants and Pollution-related Effects</u>

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

Removal of SRA Cover and Riparian Vegetation

- Reduced habitat complexity (1)
- Reduced shade along 4 miles of site length (2)
- Reduced supply of terrestrial food resources (1)
- Reduced supply of IWM (1)
- Increased exposure to predation (1)

Fully implementing the measures described in *Section 1.3.3 Conservation Measures*, would protect EFH for Pacific coast salmon by avoiding or minimizing the adverse effects described above.

4. DATA QUALITY ACT DOCUMENTATION AND PRE-DISSEMINATION REVIEW

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

4.1 Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. DWR is the intended user of this Opinion. Other interested users could include USFWS, CDFW, or the CORPS. Individual copies of this Opinion were provided to DWR. 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.

4.2 Integrity

This consultation was completed on a computer system managed by NMFS in accordance with relevant information technology security policies and standards set out in 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.

4.3 Objectivity

Information Product Category: Natural Resource Plan

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

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.

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