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

Refer to NMFS ECO #: WCR-2021-03325

May 6, 2022

Jeffrey McLain
Project Leader
U.S. Fish and Wildlife Service
Anadromous Fish Restoration Program
850 South Guild Avenue, Suite 105
Lodi, California 95240-3188

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Long Bar Salmonid Habitat Restoration Project on the Lower Yuba River

Dear Mr. McLain:

Thank you for your letter of October 20, 2021, requesting initiation of consultation with NOAA's National Marine Fisheries Service (NMFS) pursuant to Section 7 of the Endangered Species Act of 1973 (ESA) (16 U.S.C. 1531 *et seq*.) for the Long Bar Salmonid Habitat Restoration Project on the Lower Yuba River. This consultation was conducted in accordance with the 2019 revised regulations that implement section 7 of the ESA (50 CFR 402, 84 FR 45016).

Thank you, also, for your request for consultation pursuant to the essential fish habitat provisions in Section 305(b) of the Magnuson–Stevens Fishery Conservation and Management Act [16 U.S.C. 1855(b)] for this action.

Based on the best available scientific and commercial information, the enclosed biological opinion concludes that the Long Bar Salmonid Habitat Restoration Project is not likely to jeopardize the continued existence of the federally listed threatened Central Valley spring-run Chinook salmon evolutionarily significant unit (*Oncorhynchus tshawytscha*) or the threatened California Central Valley steelhead distinct population segment (*O. mykiss*), or adversely modify or destroy their designated critical habitats. NMFS has also included an incidental take statement with reasonable and prudent measures and terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the proposed project.

NMFS' analysis covers the proposed action summarized in the Biological Assessment and Biological Opinion and includes all proposed avoidance and minimization measures.

Please contact Ally Bosworth in the NMFS Central Valley Office via email at Allison.Bosworth@noaa.gov or via phone at (916) 930-5617 if you have any questions concerning this consultation, or if you require additional information.

Sincerely,

A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for
California Central Valley Office

Enclosure

cc: To the File: ARN 151422-WCR2021-SA00056

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

Long Bar Salmonid Habitat Restoration Project

NMFS Consultation ECO Number: WCR-2021-03325

Action Agencies: United States Fish and Wildlife Service (lead Federal agency), United States Army Corps of Engineers

Affected Species and NMFS' Determinations:

ESA-Listed Species	Status	Is Action Likely to Adversely Affect Species?	Is Action Likely to Jeopardize the Species?	Is Action Likely to Adversely Affect Critical Habitat?	Is Action Likely to Destroy or Adversely Modify Critical Habitat?
California Central Valley steelhead (*Oncorhynchus mykiss*)	Threatened	Yes	No	Yes	No
Central Valley spring-run Chinook salmon (*O. tshawytscha*)	Threatened	Yes	No	Yes	No

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

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

Issued By: A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for the California Central Valley Office

Date: **May 6, 2022**

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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 U.S.C. 1531 *et seq*.), as amended, and implementing regulations at 50 CFR part 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 part 600.

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (DQA) (section 515 of the Treasury and General Government Appropriations Act for Fiscal Year 2001, Public Law 106-554). The document will be available within 2 weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). A complete record of this consultation is on file at the California Central Valley Office (CCVO).

1.2. Consultation History

The list below summarizes correspondence, meetings, and discussions between NMFS, the United States Fish and Wildlife Service Anadromous Fish Restoration Program (USFWS AFRP; federal lead agency), and Cramer Fish Sciences (CFS; consultants for USFWS AFRP) that relate to potential effects of the Long Bar Salmonid Habitat Restoration Project (Project) on species addressed in this document.

- 4/15/2020 - CFS emailed Ruth Goodfield (NOAA Restoration Center) regarding the potential to use the Central Valley Restoration Project programmatic biological opinion (Programmatic Opinion; NMFS WCR-2017-8532) for the proposed Project.
- 4/23/2020 - Long Bar Project Team had a phone call with Ruth Goodfield to discuss use of the Programmatic Opinion.
- 9/24/2020 - Amanda Cranford (NMFS CCVO fishery biologist) was emailed regarding the preferred permitting path for the proposed Project.
- 2/2/2021 - NMFS received a request from the USFWS AFRP for formal consultation under the ESA for the proposed Project under the Programmatic Opinion for Central Valley (CV) spring-run Chinook salmon (*Oncorhynchus tshawytscha*) and California Central Valley (CCV) steelhead (*O. mykiss*) and their designated critical habitat. The consultation package included a biological assessment (BA) for the proposed Project. The BA identifies the South Yuba River Citizen's League (SYRCL) as the applicant and grant recipient to implement the proposed Project. In addition, The USFWS AFRP requests

consultation for essential fish habitat (EFH) for Pacific Coast Salmon under Section 305(b)(2) of the MSA.

- 2/17/2021 - Ruth Goodfield reached out to USFWS AFRP to provide the application and monitoring forms required for coverage under the Programmatic Opinion.
- 5/14/2021 - Ruth Goodfield followed up with USFWS AFRP to request the completed application and monitoring forms required for coverage under the Programmatic Opinion.
- 6/24/2021 - NMFS and USFWS AFRP discussed the proposed post-restoration monitoring associated with the Project. NMFS determined that the Programmatic Opinion could not cover the level of proposed take associated with the post-restoration monitoring activities. NMFS and USFWS AFRP agreed to schedule a follow-up meeting to discuss other options for ESA-coverage.
- 9/1/2021 - NMFS and USFWS AFRP met to discuss the preferred approach to cover both the Project construction and post-restoration monitoring activities. NMFS and USFWS AFRP agreed that a stand-alone Section 7 consultation (as opposed to coverage via the Programmatic Opinion) would be the best option for the Project.
- 10/20/2021 - NMFS received a revised request for formal consultation from the USFWS AFRP for the proposed Project to cover including the associated post-construction monitoring of salmonid species within the Project area. This request also contained the Project BA.
- 12/1/2021 - NMFS staff (Jeffrey Stuart) received the October 20, 2021, request for formal consultation.
- 12/13/2021 - NMFS sent an email to Paul Cadrett (USFWS AFRP) requesting a meeting to discuss additional information needed for the consultation regarding clarification of the numbers of fish anticipated to be taken for the Project's post-construction monitoring efforts.
- 12/16/2021 - NMFS staff (Jeffrey Stuart) met with USFWS AFRP (Paul Cadrett) and the Project's consultant (Kirsten Sellheim, CFS) to discuss the requested clarifications to the numbers of fish anticipated to be taken during the post-construction monitoring efforts.
- 12/22/2021 - NMFS received electronically the requested additional information and clarifications to the number of fish requested for post-construction monitoring efforts in a revised BA.
- 1/5/2022 - NMFS electronically sent a letter to USFWS AFRP acknowledging that it had received sufficient information to initiate formal consultation. NMFS informed the USFWS AFRP that formal consultation was initiated on 12/22/2021, and a completed biological opinion will be available on or before 5/6/2022.

1.3. Proposed Federal Action

Under the ESA, "action" means all activities or programs of any kind authorized, funded, or carried out, in whole or in part, by Federal agencies (see 50 CFR 402.02). Under the MSA, "Federal action" means any action authorized, funded, or undertaken, or proposed to be authorized, funded, or undertaken by a Federal Agency (50 CFR 600.910). We considered, under the ESA, whether the proposed action would cause any other activities and determined that it would not.

1.3.1. Federal Authorities

The Project's design, permitting, monitoring, and implementation is funded by USFWS AFRP grants to SYRCL, a non-profit organization. The United States Army Corps of Engineers (USACE) will also participate as a second federal action agency in the implementation of this Project by issuing 404 permits under the Clean Water Act (CWA) for the discharge of fill material to waters of the United States. The USACE has designated USFWS AFRP as the lead federal agency for this consultation.

1.3.2. Project Location

The Project is located approximately 15 river miles (RM) upstream from the confluence of the Lower Yuba River (LYR) with the Feather River near the community of Browns Valley, California in the Central Valley (Figure 1). The Project will take in the LYR on property owned by Long Bar Mine LLC and Western Aggregates. The Project encompasses a 6,929-ft (2,112 m) segment of the LYR between 39.224847 N, 121.398208 W (downstream limit) and 39.221136 N, 121.375767 W (upstream limit). The Project on the LYR lies within United States Geological Survey (USGS) hydrologic unit 18020107. The Project is located at 6130 Highway 20, Browns Valley, CA 95918, and is reached via an access road off Hwy 20.

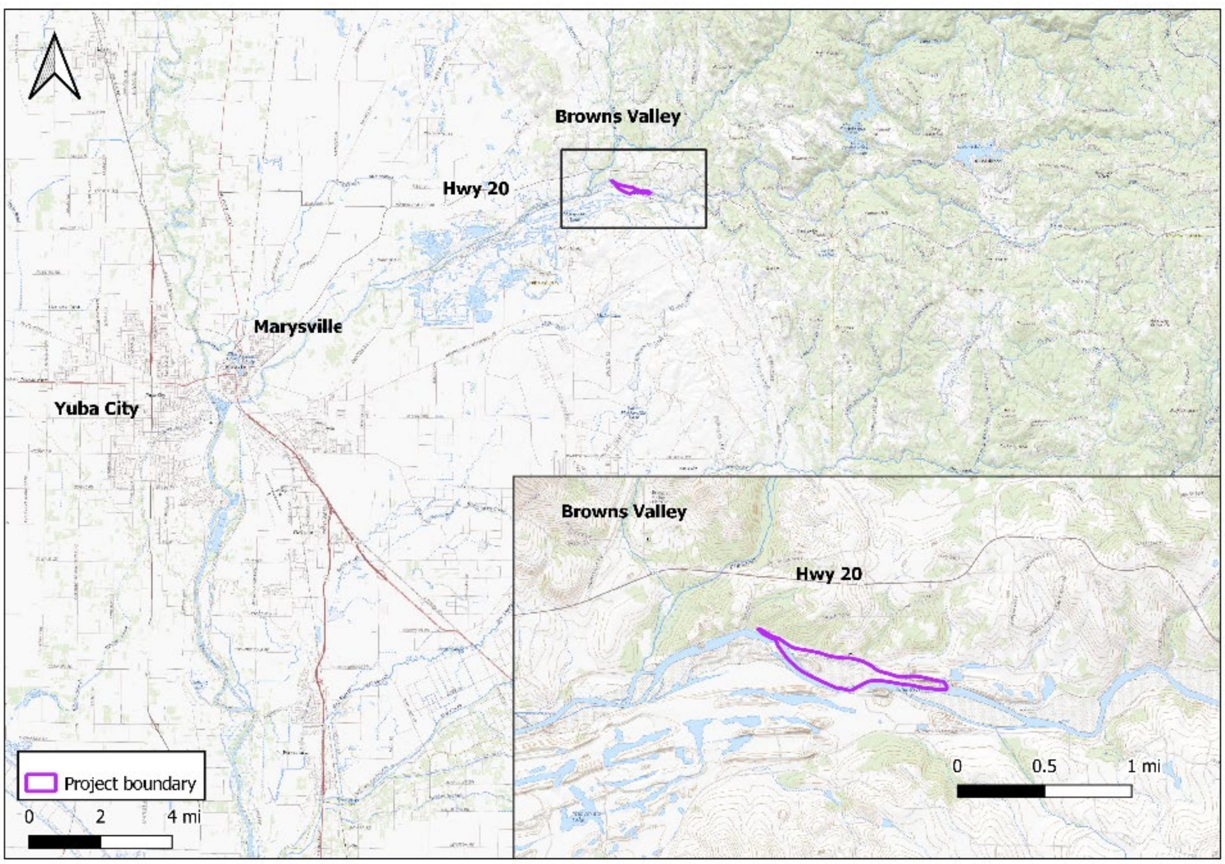

Figure 1. Location of the Long Bar Salmonid Habitat Restoration Project on the Lower Yuba River (from CFS 2021).

1.3.3. Project Purpose and Objectives

The purpose of the proposed Project is to enhance habitat for native fish species, emphasizing improvements to rearing habitat for Central Valley (CV) spring- and fall-run Chinook salmon (*Oncorhynchus tshawytscha*) and California Central Valley (CCV) steelhead (*O. mykiss*) in the LYR. The Project's goal is to protect and improve riverine habitat, resulting in benefits to fish, wildlife, vegetation, and water quality. The Project includes several components and incorporates multiple strategies to meet goals of the USFWS AFRP. These goals include long-term habitat enhancement for Chinook salmon and steelhead populations in the LYR, including recovering backwater side channel, and floodplain habitats that support juvenile salmonid growth and survival. Enhancement actions to be implemented pursuant to Section 3406(b) of the Central Valley Project Improvement Act (CVPIA) include a plan to assess the effectiveness of each action. Ensuring that each action includes monitoring is the responsibility of the USFWS AFRP, designated agencies, and partners (USFWS 2001).

The specific goals and objectives of the Project, as described in the BA (CFS 2021), are to:

- Incorporate the Project into an ecologically-sound, ecosystem context by designing the Project to function under current water management constraints (*i.e.*, timing, frequency, magnitude, and duration of elevated flows).
- Reestablish main channel and off-channel connectivity and complexity to restore ecological processes at the Project site and to increase the availability and maintenance of off-channel juvenile salmonid rearing habitats.
- Create habitat conditions suitable for spring juvenile salmonid rearing (*i.e.*, fry and sub-yearling smolts).
- As possible, create habitat conditions suitable for summer rearing of juvenile spring-run Chinook salmon and steelhead.
- Create conditions suitable for natural riparian vegetation recruitment and survival (*i.e.*, willows [*Salix* spp.], Fremont cottonwood [*Populus fremontii*], white alder [*Alnus rhombifolia*], and other riparian shrub and tree species).
- Avoid harm to existing habitat features (*e.g*., main channel spawning and incubation habitat).
- The Project aims to significantly increase suitable rearing habitat acreage through the restoration of natural ecosystem processes associated with a well-connected, frequently inundated floodplain.

A major underpinning of recovery efforts for Pacific salmon and steelhead (*Oncorhynchus* spp.) listed under the ESA is that there is a strong relationship between freshwater habitat quantity and quality and salmon abundance, survival, and productivity in the freshwater environment (Roni *et al.* 2014). This is a key component of ESA recovery plans and biological opinions for salmon and steelhead and are included in the Recovery Plan for Central Valley salmonids (NMFS 2014). Because of this assumption, it is important to: 1) document our understanding of the relationship between habitat quantity and quality and salmonid production, and 2) quantify the improvements in salmonid production and survival that can be expected with different habitat enhancement actions (Roni 2005).

1.3.4. Actions Related to the Project Elements

1.3.4.1 General Overview

The proposed Project will re-grade and rehabilitate a large gravel bar on the north side of the LYR channel adjacent to the Silica Resources Incorporated (SRI) Stringer Pit aggregate operation (Figure 2). The area of the LYR encompassing the Project is downstream and across the river from the geographic feature commonly referred to as "Long Bar." An estimated 62.4 acres of gravel bar and riparian habitat are available for rehabilitation and enhancement. A total of 42.8 acres of the gravel bar (Figure 2) will be topographically modified to enhance juvenile salmonid rearing habitat through creation of seasonally or perennially inundated side channels (upstream side channel and secondary channel; 5.9 acres), backwaters (2.4 acres), flood runner channels (1.9 acres), and backwater channel, including a perennial side channel (5.4 acres), main channel terrace (6.4 acres), and the lowering of floodplain elevations to construct riparian terrace and enhance floodplain function (20.8 acres) (Table 1). Additionally, riparian trees and shrubs will be planted adjacent to high quality re-graded areas and any large woody material removed during Proposed Action implementation will be incorporated back into proposed Project features as habitat structure.

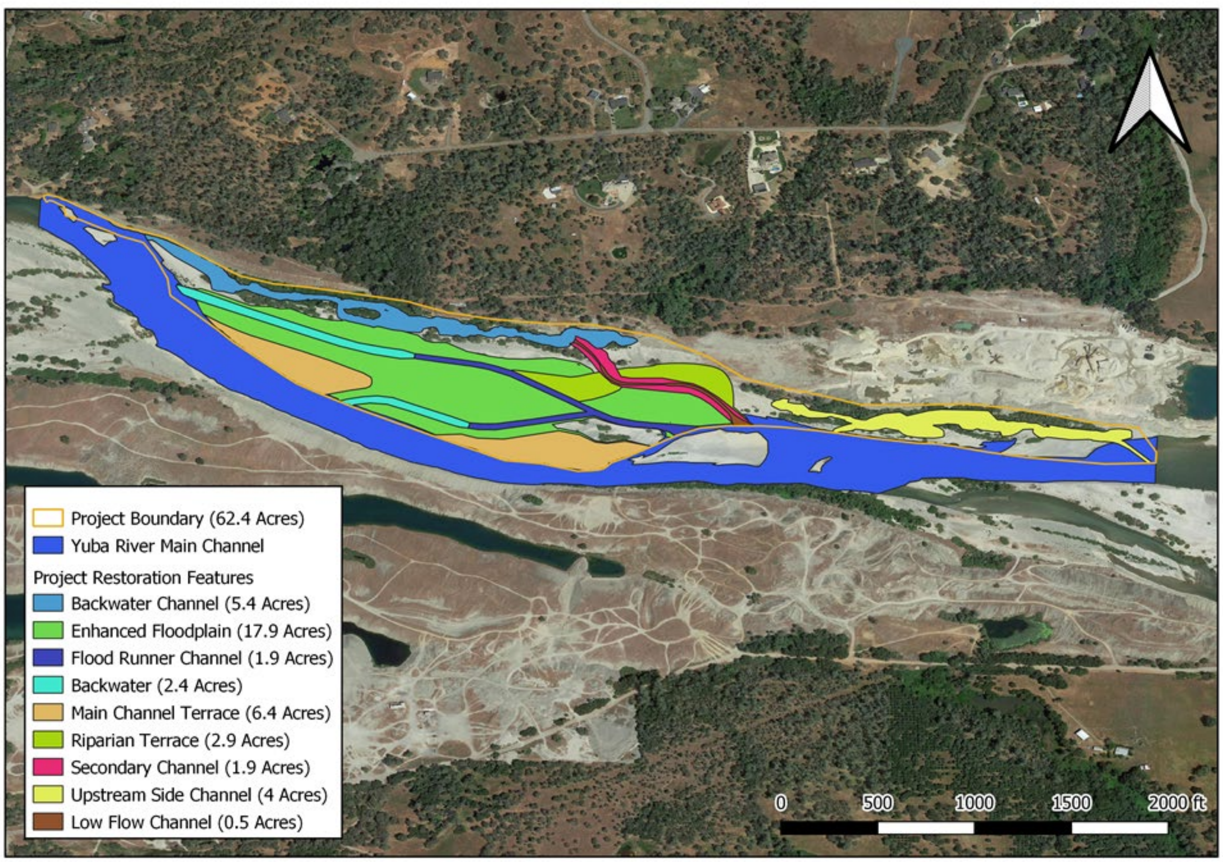

Figure 2. Proposed Project conceptual design with grading for side, secondary, flood-runner, and backwater channels, backwaters, and floodplain areas (enhanced floodplain, main channel terrace, and riparian terrace) indicated (From CFS 2021).

An estimated 331,000 cubic yards (yd^3; or 251,360 cubic meters [m^3]) of material will be excavated by heavy equipment during restoration activities and transported to the SRI aggregate operation for processing (Table 1). Heavy equipment likely to be used during the restoration Project include one or more of the following: front-end loader, scraper, grader, bulldozer, excavator, and haul truck. Native river rock excavated as part of topographic modification and/or specific sizes sorted at the SRI processing plant will be transported back to the restoration area to create specific Project habitat features, including side channel/floodplain entrances and side channel riffles.

Table 1. Estimated area and channel length of restoration habitat elements and excavation and fill volumes associated with the proposed Project on the lower Yuba River (From CFS 2021).

Habitat Element	Excavation Volume (yds^3)	Fill Volume (yds^3)	Area (acres)	Channel Length (ft.)
Upstream Side Channel	14,000	2,600	4.0	1,674
Secondary Channel (includes Low Flow Channel)	19,000	0	1.9	1,135
Riparian Terrace	31,000	0	2.9	
Main Channel Terraces	52,000	0	6.4	
Flood Runner Channel	16,000	0	1.9	2,168
Enhanced Floodplain	141,000	200	17.9	
Backwater Channel	24,000	400	5.4	2,841
Perennial Backwaters	34,000	0	2.4	
TOTAL	**331,000**	**3,200**	**42.8**	**4,430**

1.3.4.2 Project Access and Construction Timing

Access to the Project site for restoration activities will occur via the county-maintained access road at 6130 Highway 20. The paved access road is gated at the bottom where county maintenance ends. The access road to the Long Bar Mine LLC property containing the SRI plant continues past the gate. Access for restoration activities will solely be through an existing access road through the SRI aggregate operation, which leads to the gravel bar to be modified by the Project's actions (Figure 3).

Figure 3. The existing access road and staging area to be used for construction of the proposed Project (from CFS 2021).

Heavy equipment used for restoration construction will be able to drive on the gravel bar throughout the site, as it is sparsely vegetated. The staging area to be used already exists and is part of the SRI operations outside of the river channel (Figure 3). Dry floodplain grading activities may start as early as April 16 and continue as late as October 31. In-water work would only occur between July 15 and September 30 to minimize adverse effects to CV spring-run Chinook salmon, CCV steelhead, as well as other aquatic species.

1.3.4.3 Project Design Hydrology

The flow values used to develop habitat features for the Project (CFS 2021) (*i.e.,* those that possess the periods of inundation with the preferred duration and frequency over the target ecological period (*i.e.*, juvenile rearing)) are provided in Tables 2 and 3. Available literature from California's Central Valley suggests that continuous inundation duration in the range of 14-24 days, with a target of 21 days, will promote food production, providing the opportunity for aquatic benthic invertebrates (key salmonid prey items) to colonize off-channel areas (Merz and Chan 2005; Ahearn *et al.* 2006). Studies on the lower American River, a Central Valley river system similar to the LYR, have shown that floodplain invertebrate densities approach main channel densities after two to four weeks of inundation (Sellheim *et al.* in prep).

Shorter flow pulses (*e.g*., 3-day) may also be beneficial to the LYR by providing an influx of terrestrial invertebrates from the floodplain to the main channel, as hypothesized by Ahearn *et al.* (2006). Inundation frequency determines the likelihood that any anadromous salmonid year-class will have the opportunity to utilize floodplain habitats. Central Valley Chinook salmon adults typically return to spawn at age three (Fisher 1994) with variations in each brood year. As such, the population may be continually supported by a benefit to juveniles that occurs as seldom as one in three years. Three frequencies were used for the Project design: 1) 33% exceedance probability, or the specified inundation duration during the specified rearing period occurring in one of every three years; 2) 50% exceedance probability, occurring every other year; and 3) 67% exceedance probability, occurring two out of three years, on average (Table 2).

Table 2. Summary of ecologically significant flows guiding Project design (from CFS 2021).

Monthly Period	**January to June**			**January to June**			**July to October**
Flow Duration	**21-day Duration Flow, cubic feet per second (cfs)**			**3-day Duration Flow (cfs)**			**Baseflow (cfs)**
Exceedance %	**33%**	**50%**	**67%**	**33%**	**50%**	**67%**	**-**
Yuba River Development Project (YRDP) Model[1]	5,000	4,100	2,000	10,400	6,900	3,800	700

Based on the ecological flow evaluation above, design flows were developed to govern the development of habitat enhancements. Table 3 lists the various design flows along with their ecological importance and their significance related to physical processes.

Table 3. Design flows based on Ecosystem Function Model results from the YRDP model (from CFS 2021).

Flow (cfs)	**Ecological Significance**	**Physical Process Significance**
700	Minimum required flow 1 September-15 April	Base flow conditions
880	Typical Chinook Salmon spawning flow	Main channel spawner bed modification (Hassan *et al.* 2008; DeVries 2012)
1,000	Upper end of Chinook Salmon spawning flow	Surface water flow disconnection to all floodplain features (cbec design)
2,000	21-day duration occurring almost every year (January to June); lower end of rearing range	Channel defining flow for Secondary Channel geometry (cbec design)

Flow (cfs)	Ecological Significance	Physical Process Significance
3,500	21-day duration approximately every other year; activates riparian corridor	Potential for vegetation and sediment recruitment feedbacks (cbec design)
5,000	21-day duration every third year; upper end of steelhead spawning	LYR bankfull (Kammel and Pasternack 2014)
7,500	Occurs for ~3 days every other year; provides access to floodplain	Potential for vegetation and sediment recruitment feedbacks (cbec design)
10,000	Upper end of rearing range	~1.5-year recurrence interval flood; Secondary Channel riffle-pool maintenance
40,000	Linked to implications for the floodway	~5-year recurrence interval flood; material critical grain size threshold (cbec design) for riffle crests, inlets, and roughness features
70,000	Linked to implications for the floodway (scour and vegetation regeneration); vegetation recruitment assumptions	~10-year recurrence interval flood

Considerations of sub-surface flows and depth to groundwater were also parameters in the design of the Project. Sub-surface flows and shallow depths to groundwater enhance riparian plant growth on bars and floodplain areas. Additionally, to maintain appropriate water temperature to support over-summer salmonid rearing, the low flow portion of the Secondary Channel and the Backwater Channel are designed to convey groundwater input in late summer and fall when the channels are disconnected from surface flow (CFS 2021).

1.3.4.4 Project Habitat Design Elements

Project design elements are described in the BA for the Project (CFS 2021) and are provided below. Channel and floodplain grading designs were based on site hydrology and geomorphic considerations (*i.e.*, evolution and persistence). Hydrology was evaluated to determine ecologically significant flows that occur during the juvenile salmonid rearing period. The goal of floodplain and channel grading was to provide inundation throughout the range of ecological flows, so water surface elevations associated with those flows were used as grading design criteria. Habitat features were designed to "initiate" or begin to inundate at the approximate flows listed in Table 4 to develop inundation depths that would satisfy the needs of juvenile salmonids over the rearing period according to selected habitat suitability indices (CFS 2021).

Table 4. Summary of design habitat elements and flow criteria (from CFS 2021).

Habitat Element	Flow Initiation (cfs)	Flow Functional Range (cfs)	Inundation Analysis Flow (cfs)	Timing	Duration (days)	% Exceedance
Secondary Channel	2,000	2,000-5,000	2,000	Jan - June	21	67%
Backwater Channel	700	700-5,000	2,000	Jan - June	21	67%
Upstream Side Channel	2,000	2,000-10,000	2,000	Jan - June	21	67%
Flood Runner Channels (frequent flows)	3,000	3,500-10,000	3,500	Jan - June	21	50%
Riparian Terraces[1] (seasonally inundated, off-channel habitat)	2,000	5,000-10,000	3,500 / 5,000	Jan - June	21	33-50%
Backwaters	700	700-5,000	2,000	Jan - June	21	67%
Enhanced Floodplain	5,000	5,000-26,000	10,000	Jan - June	3	33%
Main Channel Terraces	1,000	2,000-10,000	2,000	Oct - June	21	67%

1.3.4.4.1 Element Descriptions

The following descriptions of Project elements are excerpted from the BA for the Project (CFS 2021). Additional information regarding habitat suitability modeling is also provided in the BA (pages 27 through 31), and is incorporated by reference into this biological opinion.

Secondary Channel Features

During base flow conditions, when total LYR flow upstream of Daguerre Point Dam is around 700 to 1,000 cfs, the Secondary Channel will not exhibit a direct surface connection to the main channel at the upstream inlet connection. Base flows occur in most years from mid-August to October, corresponding to the latter portion of the adult Chinook salmon immigration period, peak spring-run Chinook salmon spawning, and the beginning of fall-run Chinook salmon spawning. During this period, there is a focus on providing deeper, colder, main channel habitat for adult Chinook salmon. It is not desirable to distribute the limited surface water flows onto the floodplain or Secondary Channel because if redds are built in these areas, they are at risk of becoming stranded if flows are subsequently reduced.

The sectional design geometry of the Secondary Channel is planned as a combination of four different functional elements: 1) Inlet, 2) Riffles, 3) Low Flow Channel, and 4) Floodplain Terraces. A description of the geometric considerations for these elements follows.

Inlets

Secondary Channel and Upstream Side Channel inlet elevations were set to approximate the 2,000-cfs water surface elevation (WSE) to correspond with the habitat goals for the channels. Because the inlets were designed to divert flows from the main channel when total river flows exceed 2,000 cfs, spawning habitat in the main channel should not be affected, as spawning typically occurs when main channel flows are below 1,000 cfs. Inlet mouth sections are narrow by design to maintain their form by inducing sediment-clearing flow velocities and are located outside of geomorphically active areas to avoid sedimentation or scour.

Riffles

Riffles were included in the design in the pattern and form identified by Newbury and Gadboury (1993) (also known as Newbury riffles) to provide habitat variability, increase floodplain connectivity, and provide grade control in the Low Flow Channel (Figure 2). Three distinct habitat units are created by the inclusion of Newbury riffles in the Proposed Action: an upstream glide/pool section, a riffle section, and a downstream transition section. Riffle spacing was designed so that the downstream riffle backwaters the majority of the riffle upstream, creating a series of pools 1 to 2.5 feet in depth to target rearing juvenile salmonid habitat suitability index (HSI) values and to provide dry season groundwater-fed habitat. The backwater created by the pools will reduce the hydraulic slope and flow velocity in the Secondary Channel to help maintain velocity within target HSI values. As flows approach the riffle crest, the channel conveyance is reduced, encouraging flows to disperse laterally onto the adjacent floodplain.

The Low Flow Channel riffles are anticipated to be a self-sustaining feature that will maintain channel form by facilitating the flushing out of finer pool sediments during relatively high recurrence flow events. In low flows, velocity in the pools is slower than over the riffles due to the relatively larger cross-sectional area. In higher flows, the cross-sectional area of the riffles can exceed that of the pools, as flows spread out over the riffle (Lane and Borland 1954). This leads to a “flow reversal” (Keller and Florsheim 1993; MacWilliams *et al.* 2006) in which the pool velocities are higher than those over the riffle. The higher flow velocity in the pools may assist in maintaining pool depth and riffle form by removing sediment from the pools and distributing it to the floodplain adjacent to the riffles, or to the riffles downstream (Lane and Borland 1954). The Floodplain Terraces allow flows to spread onto a wider floodplain and slow down, reducing the shear stress, or erosive power. The Secondary Channel flows required to activate this process are associated with an approximate 1.75-year recurrence interval flow.

Low Flow Channel

The channel that serves as a connection between the upstream end of the Backwater Channel and the main channel is a two-stage design, with a Low Flow Channel and shallow Floodplain

Terraces. The Low Flow Channel profile elevation varies to allow for perennial, groundwater-fed, trickle flows through a series of shallow riffle habitats separated by deeper pool and glide habitats. The Low Flow Channel was designed as a patterned sequence of deeper and narrower areas (pools) followed by wider and shallower areas (riffles) imitative of natural, gravel-bedded river forms.

The Low Flow Channel was designed to maintain full depth during dry year base flow conditions, when it is disconnected from surface flow, to provide habitat for over-summering juvenile spring-run Chinook salmon and CCV steelhead. The Low Flow Channel geometry is designed to provide a continuous, wetted channel in the dry months in approximately half of all years. The Secondary Channel riffle crest elevations were set six inches below the estimated groundwater elevation to provide egress for juvenile salmonids from the pools they form. Pool depths were set to 2.5 feet to discourage the occurrence of deep-bodied predatory species, such as black bass (*Micropterus* spp.), which have a higher probability of occupancy at depths exceeding this value (CFS 2018).

Floodplain Terraces

The Low Flow Channel is set into broad and shallow Floodplain Terraces, comprising the Secondary Channel (Figure 2). The alignment of the Low Flow Channel moves with respect to the Floodplain Terraces, swinging left and right to move to the outside of bends. As the Low Flow Channel position moves to the outside of the bend, the Floodplain Terrace area increases on the inside of the bend. This design mimics natural channel morphology, promoting helical flow patterns and floodplain activation.

The Floodplain Terraces of the Secondary Channel are designed to disperse flows out of the Low Flow Channel, creating a broader refuge area with reduced velocity. The Floodplain Terraces connect to Riparian Terrace features on the north and south sides of the Secondary Channel.

Riparian Terraces

A Riparian Terrace is featured on the south side of the Secondary Channel that contributes to the performance of the Backwater Channel by providing a connecting channel from the Backwater Channel to the main river via the Flood Runner Channels. The Connector Channel is intended to divert water away from the Backwater Channel as main channel flows increase, thereby reducing depth and velocity in the Backwater Channel and extending its function as a refuge for rearing fish. The Connector Channel is a wide, shallow channel that extends from the top of bank on the south side of the Secondary Channel to the Flood Runner Channel. While it serves to divert water away from the Backwater Channel, it also provides expanded floodplain habitat over the upper range of ecological flows associated with salmonid rearing (5,000 to 10,000 cfs).

A Riparian Terrace is also included on the north side of the Secondary Channel to disperse flows and reduce channel velocity. This Riparian Terrace slopes up from the top of bank of the Secondary Channel Floodplain Terrace, activating around 5,000 cfs. This feature is intended to disperse flows on the higher end of the ecological flows range to maintain the effectiveness of the Secondary Channel and Backwater Channel to provide habitat value to rearing juvenile salmonids at these flows.

Backwater Channel

The Backwater Channel is an existing feature on the north side of Long Bar that will be enhanced through opportunistic grading to develop perennial access to high quality edge habitat. Perennial access will be provided by maintaining a minimum depth in the channel and lowering local high spots to provide continuous egress to the outlet at the downstream end. The bed of the Backwater Channel grading was designed to provide one foot of depth during the low water period, based on the estimated groundwater elevation surface. Existing vegetation will be preserved to the extent practicable to maintain existing habitat value and grading will be designed to increase edge length and to bring the channel edges closer to overhanging vegetation. Because the area is spatially small and narrow, it is anticipated that it will function best as rearing habitat over the lower end of the range of ecological flows associated with salmonid rearing (2,000 to 5,000 cfs), which occur over a 21-day duration as frequently as two out of three years, but not less than one out of three years. The enhanced perennial access will also provide increased habitat for over-summering juvenile CV spring-run Chinook salmon and CCV steelhead.

Enhanced edge habitat will be provided by widening the channel, opportunistically, to bring the edges of the feature into contact with existing vegetation. Grading extents were based on observed vegetation in aerial photos. A varied bank line was established to increase edge length and to incorporate flow diversity in the design to provide habitat variability. Design grading elevations along the edges of the Backwater Channel were set to provide topographic heterogeneity such that the feature functions over the lower end of the range of ecological flows.

By enhancing pool connectivity and communication of groundwater inflows throughout the Backwater Channel, the design is intended to reduce water temperatures in summer. This, in turn, should improve over summering habitat for salmonids while also reducing bullfrog habitat suitability in the Backwater Channel.

Upstream Side Chanel

Like the Backwater Channel, the Upstream Side Channel is an existing feature that will be enhanced to provide increased access to and egress from the floodplain. The flow connection to this channel will be enhanced by extending a small channel upstream to connect with the main channel, with a design elevation to activate at main channel flows of 2,000 cfs. A narrow, shallow central channel is included in the design to convey flows from the upstream inlet to the downstream outlet, providing constant slope and drainage to minimize fish stranding potential. The central channel is designed to have a minimum depth of six inches to encourage spreading of flows onto the broad floodplains adjacent to it. Floodplain grading around the central channel was designed to activate just above flows of 2,000 cfs in the main channel. Main channel flow and floodplain elevations were varied to provide suitable depth and velocity over the range of ecological flows associated with salmonid rearing (2,000 cfs to 10,000 cfs). A varied bank line will be established to increase proximity to vegetation and edge length, and to create flow velocity diversity. Grading extents were based on vegetation observed in aerial photography taken in 2017.

Isolated pools currently exist in the area where the Upstream Side Channel will be constructed. Similar to the Backwater Channel, Upstream Side Channel grading will connect these pools together and with the groundwater elevations underlying them with the intention of enhancing circulation of groundwater in the summer and lowering water temperatures in the pool system. This provides over summering habitat for salmonids as well as reducing bullfrog habitat suitability.

Flood Runner Channels

The Flood Runner channels are intended to mimic natural features that form on bars due to scour during elevated flows. The Flood Runner channels will provide off-channel rearing habitat through regular and sustained shallow inundation of these channel features in most years. Main channel flows are expected to exceed 2,000 cfs for a duration of 21 days in two out of three years (*i.e.*, 66% exceedance) and to exceed 4,100 cfs for a duration of 21 days in one out of two years (*i.e.*, 50% exceedance) (Table 2). The Flood Runner channels were designed to activate at main channel flows of 3,000 cfs, meaning it should be inundated for a 21-day period at least every other year.

The Flood Runners were designed to provide shallow-water habitat within their banks and access to the larger, open floodplain areas that surround them as flows increase. The channels have a bottom width of 30 feet, are nine inches deep, and are anticipated to be full at main channel flows of 3,500 cfs. As main channel flows increase to 5,000 cfs, the banks of the Flood Runners are anticipated to be covered by six inches of water, and flows should spread out onto the larger Enhanced Floodplain on either side of the Flood Runner channels.

Perennial Backwaters

Backwaters, defined as partially enclosed, low-velocity areas separated from the main channel, were designed to create shallow, slack-water areas that salmonids have shown preference for over higher velocity in-channel habitats (Beechie *et al.* 2005). The Backwaters will provide habitat diversity and increase edge habitat during the rearing period, as well as the low-flow period to benefit over-summering juvenile CV spring-run Chinook salmon and CCV steelhead. Backwaters were designed to perform during main channel flows ranging from base flow to 5,000 cfs. Backwater bed elevations were set for shallow inundation (less than 1 foot) during main channel flows of 1,000 cfs and less than 3 feet depth at 5,000 cfs. The Backwater channels were sloped toward the downstream ends to allow egress from the upstream end of the Backwaters and adjacent floodplain areas. Inundation depths and seasonality were reviewed with respect to predator habitat preferences to confirm the Backwaters do not provide favorable conditions for non-native predators, such as black bass (CFS 2018).

Enhanced Floodplain

In addition to the riparian terraces surrounding the Secondary Channel and the fringes of the Backwater Channel and Upstream Side Channel, the Project design also includes several larger areas of restored floodplain habitats. These areas are located on the larger degraded portion of Long Bar, adjacent to the Flood Runner channels. Enhanced Floodplain elevations were set to provide inundation of the entire graded floodplain area for a period of 21 days in one out of three years (*i.e.*, 33% exceedance), which corresponds to a main channel flow of approximately 5,000 cfs. These floodplain areas are intended to provide additional inundated acreage at the upper end of the targeted range of ecological flows (5,000 cfs to 10,000 cfs), and to provide a depth to groundwater that will promote native riparian vegetation establishment and recruitment.

Main Channel Terraces

Large areas of more frequently inundated floodplain were added to the design adjacent to the main channel. The elevations of these large terraces were designed to maintain in-channel flows during the spawning season, and to potentially activate during all other times of the year to provide a significant addition to available shallow edge habitat in the Project's footprint. The terraces slope gently toward the main channel at variable slopes. The edges adjacent to the main channel are anticipated to inundate around 1,000 cfs and the highest portion of the terraces are anticipated to become submerged at a flow of 2,000 cfs in the main channel. The variation in elevation in the terraces was intended to promote utilization of these areas over the range of ecological flows associated with salmonid rearing (2,000 cfs to 10,000 cfs).

Roughness Features

Inorganic roughness features were added to areas of broadly graded floodplain (Enhanced Floodplain, Main Channel Terraces) to add hydraulic variability (*i.e.*, flow velocity and depth), provide refuge areas, and to promote fine sediment accretion. These features are oriented to form ridges perpendicular to flow to encourage sediment deposition on the downstream side of the ridge. The ridges will be constructed of locally available, well-graded, rounded rocks, stacked approximately three to six feet high on the floodplain. These features will have 3:1 slopes.

Riparian Habitat Area

Benefits to rearing salmonids from riparian habitat include refuge from predation and high velocities, shading impacts on water temperature, allochthonous nutrient and prey (invertebrate) contributions, and woody material inputs that enhance cover and habitat complexity (Bisson *et al.* 1982; Eberle and Standford 2010; Sellheim *et al.* 2016a). Floodplain grading was designed according to the hydrology that will support both rearing juvenile salmonids and vegetation recruitment and establishment. The resulting range of elevations, inundation frequencies, groundwater depths and flood energy are intended to generate a diverse mosaic of habitat types for juvenile salmonid rearing and riparian vegetation.

Recruited floodplain vegetation is expected to create hydraulic roughness, reduce flow velocity, and encourage sediment deposition that will promote the natural recruitment process (Bendix and Hupp 2000; Manners *et al.* 2013; Yager and Schmeeckle 2013). Established floodplain vegetation roots are expected to stabilize the soil and help sustain the form of the floodplains and channels designed to convey water through them.

A secondary goal of floodplain grading is to increase edge contact with vegetation. Where possible, floodplain grading was extended to meet existing vegetation, as interpreted from aerial photos form 2017. Provision will be made for adaptive grading during construction to preserve existing vegetation and to maximize shaded edge habitat. Floodplain grading will require removal of existing vegetation in some instances; the resulting woody debris will be utilized within the Project area as appropriate to provide additional cover for juvenile salmonids.

1.3.4.5 Project Construction Elements

In order to accomplish the grading and re-contouring of the Project site to meet the design elements, heavy construction equipment is required to move the rock, stone, and soil materials to reach the specified contours and elevations required by the element's design. This equipment will consist of the following types: front-end loader, scraper, grader, bulldozer, excavator, and haul truck. By necessity, heavy construction equipment will operate within the stream channel below the ordinary high-water mark, and will include operations within the wetted channel itself. In-water construction activities will typically begin at the most upstream part of the Project element and work their way progressively downstream. Native river rock excavated as part of topographic modification and/or specific sizes sorted at the SRI processing plant will be transported back to the restoration area to create specific features, including side channel/floodplain entrances and side channel riffles.

In addition to the use of heavy construction equipment to move rock and gravel materials, hand and power tools will also be utilized. These pieces of equipment will typically be used to prune, cut, or remove vegetation as necessary to achieve Project design goals. Equipment such as chainsaws, pruners, shovels, and pick axes are expected to be used.

1.3.4.6 Proposed Project Monitoring

The Monitoring Plan follows a Before-After-Control-Impact (BACI) design to account for background variation in success metrics with the primary goal of defining the current state of the system before restoration and determining whether the implemented Project has had the desired effect on target species and overall system health. The monitoring program consists of four monitoring stages: 1) pre-project site description, 2) implementation, 3) effectiveness, and 4) validation (Table 5). Pre-project monitoring helps identify the baseline for the Proposed Action, including the identification of deficiencies in ecosystem health, and is necessary to detect change over time (Roni 2005). Implementation monitoring will determine if the Proposed Action was constructed according to the design standards. Hydrology, topography and bathymetry, sediment dynamics, and vegetation will be assessed. Effectiveness monitoring will determine if the Proposed Action was effective in meeting target physical and biological objectives. A range of physical and biological traits will be tracked before and after restoration to assess ecosystem function. Pre-project monitoring is essential for effectiveness monitoring because it establishes an objective baseline of ecosystem function with which to evaluate change caused by Proposed Action implementation. Finally, validation monitoring will be conducted to substantiate the underlying assumptions of the restoration work and determine if restoration projects, like the Proposed Action, recover productive habitat that promotes juvenile Chinook salmon and steelhead growth and riparian vegetation recruitment.

Table 5. Monitoring Stages Associated with the Proposed Project (from CFS 2021).

Monitoring Stage	Question Addressed	Time Frame
Pre-project	What is the baseline condition of the site? Does the site contain special-status species?	1-3 years before project implementation
Implementation	Was the project installed as planned?	2+ years
Effectiveness	Was the project effective at meeting restoration objectives?	1 year to decades
Validation	Are the basic assumptions behind the project conceptual model valid?	1-10 years

Sampling sites will be stratified and randomized in the BACI context, and replicate samples within these sites will be collected. Sampling sites will be upstream, within, and downstream of restored reaches. Within the project area, three off-channel (side channel, backwater, floodplain) and three main channel (glide, run, riffle) habitat types will be sampled.

1.3.4.6.1 Fish Monitoring Surveys

Fish Community

Snorkel surveys will be conducted to test hypotheses related to juvenile use of the restored treatment and unrestored control sites (Table 6). Surveys will be conducted in the spring through summer period, coinciding with rearing for juvenile CV fall-run Chinook salmon (spring), CV spring-run Chinook salmon (spring and summer), and CCV steelhead (spring and summer; (Table 7). Fish will be observed, identified, and counted by size group. Counts will later be converted to densities (fish/m^2) using the transect length and a standard width of two meters/snorkeler to calculate total area sampled. Fish will be categorized by species and size class. In addition, physical (water depth and velocity) and environmental (habitat cover, stream position, substrate type, *etc*.) parameters will be collected.

Table 6. Effectiveness Monitoring Questions and Parameters Measured (from CFS 2021).

Question	Parameter
1. Will restored habitat support greater densities of juvenile salmonids compared to unrestored habitats?	Snorkel surveys
2. When off-channel habitat is fully restored, will more complex side channel and backwater habitats support greater densities of juvenile salmonids than floodplain habitat?	Snorkel surveys
3. Which off-channel habitats (side channels, backwater, floodplain) support greater densities of juvenile salmonids over the duration of the rearing season?	Snorkel surveys
4. Will cover features (*e.g.*, large wood, boulders) increase the probability of juvenile salmonid habitat occupancy?	Physical structure mapping (woody material, aquatic and riparian vegetation) Snorkel surveys
5. Will restored habitats support greater drift and/or benthic macroinvertebrate density relative to unrestored habitats and pre-restoration conditions? Will densities differ between off-channel habitats?	Macroinvertebrates (density, biomass)

Table 7. The critical periods for CV fall-run and spring-run Chinook salmon and CCV steelhead within the Action Area. The dark gray squares represent the primary period of occurrence for that life stage. Light gray squares represent the secondary period. White squares indicate absence of the life stage (from CFS 2021).

Species/ Life Stage	Yuba River Distribution	Month Present											
		Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Central Valley Fall-Run Chinook Salmon													
Adult holding and spawning	Feather River confluence to Englebright Dam									Light gray	Dark gray	Dark gray	Light gray
Egg incubation	Feather River confluence to Englebright Dam	Light gray	Light gray							Light gray	Dark gray	Dark gray	Dark gray
Juvenile emergence and rearing	Feather River confluence to Englebright Dam	Dark gray	Dark gray	Dark gray	Light gray	Light gray							Light gray
Juvenile/smolt out-migration	Feather River confluence to Englebright Dam	Dark gray	Dark gray	Dark gray	Light gray	Light gray	Light gray						Light gray
Central Valley Spring-Run Chinook Salmon													
Adult migration and holding	DPD pool and locations upstream.			Light gray	Light gray	Dark gray	Dark gray	Dark gray	Dark gray	Light gray			
Adult spawning	Primarily upstream of DPD.									Dark gray	Light gray		
Egg incubation	Primarily upstream of DPD.									Dark gray	Dark gray	Dark gray	Light gray
Juvenile emergence and rearing	Primarily upstream of DPD.	Dark gray	Dark gray	Light gray	Light gray	Light gray	Light gray	Light gray	Light gray	Light gray	Light gray	Dark gray	Dark gray
Juvenile/smolt out-migration	Feather River confluence to Englebright Dam	Dark gray	Dark gray	Dark gray	Light gray							Light gray	Dark gray
California Central Valley steelhead[c]													
Adult migration	Feather River confluence to Englebright Dam								Light gray	Dark gray	Dark gray	Dark gray	Light gray
Adult spawning	Primarily upstream of DPD.	Dark gray	Dark gray	Light gray								Light gray	Light gray
Egg incubation	Primarily upstream of DPD.	Dark gray	Dark gray	Dark gray	Light gray								Light gray
Juvenile emergence and rearing	Primarily upstream of DPD.	Light gray	Light gray	Light gray	Dark gray	Dark gray	Dark gray	Light gray	Light gray	Light gray	Light gray	Light gray	Light gray
Juvenile/smolt out-migration	Feather River confluence to Englebright Dam		Light gray	Dark gray	Dark gray	Light gray	Light gray						

Juvenile Chinook Salmon Rearing Experiment

Previous studies have suggested that fish rearing in off-channel habitats exhibit enhanced growth and survival as compared to those in the main channel (Sommer *et al.* 2001; Jeffres *et al.* 2008). Backwater/alcove habitat is relatively common in the LYR, but it is unknown if this habitat would provide similar growth/survival benefits as demonstrated by previous off-channel habitat studies. To examine this concept, the Project proposes to tag juvenile Chinook salmon with passive integrated transponder (PIT) tags captured by beach seine (see beach seining method description below) and allow them to rear in the backwater habitat at the restoration sites and in an unrestored backwater habitat before and after restoration to test the hypothesis that juvenile salmon rearing in restored off-channel habitats will exhibit greater growth rate and health condition than those that rear in unrestored backwater habitats (Table 8).

Table 8. Rearing Experiment Questions and Parameters Measured (from CFS 2021).

Question	Parameters Measured
Will juveniles that rear in restored off-channel habitats exhibit greater growth rates than those that rear in non-restored habitats?	Juvenile rearing experiment (growth from recaptures and otoliths)
Will juvenile salmonid diet composition and fullness differ before and after restoration, and as compared with an unrestored control site?	Juvenile rearing experiment (stomach contents)
Will the abundance of invasive predatory fish decrease following restoration?	Snorkel surveys

The juvenile Chinook salmon-rearing experiments will use Chinook salmon captured by beach seining in the backwater habitat. The proposed experiment will use up to 500 fish at each location (restored backwater and control site) to study growth in the control and restored backwater habitats. All natural-origin juvenile Chinook salmon captured by seining that are PIT-tagged will also have a genetic tissue sample/swab collected from them to determine run assignment (spring-run vs. fall-run) using genetic analysis. This will allow for individual identification of each fish via the PIT tag code and the run assignment of that fish in subsequent studies. In addition, the ratio of spring-run to fall-run Chinook salmon among PIT-tagged fish can be expanded to other natural-origin juvenile Chinook salmon captured by beach seine or in the fyke net, which are not genetically analyzed for run assignment to determine take of listed fish over the course of monitoring studies.

Prior to the release of the PIT-tagged juvenile Chinook salmon into the backwater study areas, a fyke net will be deployed at the exit of the water body to intercept all fish moving downstream towards the main channel. If necessary, an additional net may need to be set up at the upstream end following restoration to prevent PIT-tagged fish from migrating upstream out of the system.

Traps will be checked daily, and each captured salmon will be scanned with at PIT tag reader, its size (fork length [FL] and weight) recorded, and a photo taken. Incidental catch (including all native and non-native fish species) will also be recorded and measured to provide additional data on fish assemblages. A sub-sample (a of total 100 fish; 50 from Project and 50 from Control) of PIT tagged natural origin fall-run Chinook salmon (as determined by the genetic assignments) recaptured in the fyke net will be euthanized and preserved in small vials containing 100% ethanol. All other fish will be released unharmed downstream of the trap.

To determine the health condition of the euthanized fish, lipid content of each fish will be measured. Stomach contents will also be analyzed following recapture to assess prey biomass and composition. In addition, smoltification levels will be determined to test for differences in development trajectories between fish in restored and unrestored habitats. This will be accomplished quantitatively using either a handheld chromameter or by taking standardized photos and testing for differences in light reflectance across treatments. Otoliths will also be collected from a sub-set of the sacrificed juvenile Chinook salmon. Daily increments in ring widths will be measured using imaging analysis software and a daily growth will be calculated.

1.3.4.6.2 Macroinvertebrate Sampling

Restoration actions including creation/enhancement of side channels and floodplains are predicted to increase the density and biomass of macroinvertebrates in the drift (Table 6, Question 5). To address this hypothesis, the Project will use drift sampling to sample both terrestrial and aquatic invertebrates that are present in the drift and readily available for drift-feeding juvenile salmonids during the time period that they are present (January through October). Drift samples would be collected pre- and post-project at both control and treatment sites. Drift macroinvertebrate communities will be monitored through the spring and summer to determine the composition and abundance of various species available to juvenile salmon as prey items. Replicate macroinvertebrate samples will be collected using drift nets from habitats with sufficient flow. Drift insects will also be collected using a drift sampler with 106-µm mesh pulled for 32.8 feet (10 m) across the water's surface. In addition, replicate samples will be collected from all habitats using Schindler traps, which involve taking a standardized water sample from the water column and do not require flowing water to collect samples. All collected samples are rinsed into 500 mL labeled bottles containing 70-95 percent ethanol as a preservative. Samples will be transported to the laboratory and sorted under a light dissecting scope (*e.g.*, 60X) to determine species composition, size groupings, and life stages present in the control and restored habitats.

1.3.4.6.3 Sampling Methodologies

Beach Seine Sampling

In general, a 50-foot wide seine net with 1/8-inch mesh will be used for beach seine sampling. However, a smaller width and/or mesh size may be used depending on seining location and timing. At each seining location, three non-overlapping seine hauls will be performed. Seine hauls are typically performed parallel with shore. The seine is stretched out moving in the upstream direction until it is the full width and parallel to shore and then it is pulled by the team into the shore. The team will work together to keep the lead line down while bringing it into shore, making sure that the floats stay at the water surface. If any rocks, sticks, or other objects are caught in the seine, they will be removed to avoid crushing fish and damaging the seine. Water volume sampled is calculated from the length, width and depth of haul area and is used as a metric of effort. After most of the debris has been removed, fish will be concentrated into a small pocket in the seine and removed either by hand or with a net. Fish captured from each seine haul will be stored in separate 5-gallon buckets containing fresh water and an aerator or live-cars secured in the body of water being seined. No more than 25 fish will be placed into any one bucket, and a live car will be used if water or air temperatures are high enough to pose a threat to the viability of captured fish. Buckets or live cars should be placed in the shade, and a canopy set up if no natural shade is available. Water quality (temperature and dissolved oxygen [DO]) of recovery buckets will be monitored frequently and water changed if needed, particularly if air temperatures are high. Captured fish will be processed separately for each site using standard procedures, described below. All captured fish will be released in the area of capture after recovering from processing except for juvenile Chinook salmon selected to be used in the juvenile rearing experiment.

Fyke Net Sampling

Fyke net sampling will be used as part of the juvenile Chinook salmon rearing experiment. A 4-foot-tall by 5-foot-wide fyke net made of 1/4-inch nylon mesh or a 3-foot-tall by 4-foot-wide fyke net made of 1/8-inch nylon mesh, both with 25-foot wings, will be used for trapping. The cod end of the fyke net will be connected to a live box that is 4-feet long, 2.5-feet wide, and 2.5-feet high. A velocity break will be inserted into the live box to ensure that captured fish are not impinged upon the back of the box. The fyke net will be placed in the downstream end of the backwater channel and the wings extended as necessary by adding additional ¼- or $^{1}/_{8}$-inch nylon mesh panels to cover the width of the channel. The fyke net is planned to be "fished" continuously during the experiment but may be temporarily removed in advance of a forecasted high flow event that could potentially damage or destroy the equipment.

Depending on the number of fish captured and the observed volume of debris loads, the live boxes will be checked once or twice a day, typically in the morning and afternoon. All captured fish will be processed and debris cleaned from the traps and live boxes. All fish in the live box will be processed by netting out individual fish using aquarium nets and placing them in five-gallon buckets of fresh river water. Larger, piscivorous fish will be placed in separate buckets from juvenile salmonids and other smaller fish to prevent predation. Water in the buckets will be monitored to ensure that temperature remains within 2 degrees Celsius (°C) of the river water and DO is above five milligrams per liter (mg/L). Water will be replaced and aerators used, as necessary, to maintain acceptable water quality.

All non-target fish captured in the fyke net will be identified to species, enumerated, and released. All salmonids with a fork length (FL) greater than 50 mm will be anesthetized, measured and weighed, and scanned for a PIT tag, while salmonids with a FL less than or equal to 50 mm will only be anesthetized and measured. After processing, the fish will be immediately placed in a recovery bucket with a battery-powered aerator supplying bubbled air. Once all fish in the recovery bucket are behaving normally, they will be released immediately downstream of the live box (except for the subsample of 100 recaptures that will be sacrificed for otolith and stomach content analysis).

Anesthesia

Fish required to be anesthetized will be placed in a five-gallon bucket containing an anesthetic solution created by adding Alka Seltzer Gold brand sodium bicarbonate ($NaHCO_3$) or MS-222 to fresh river water. The lowest concentration of sodium bicarbonate or MS-222 to allow safe fish handling will be used and will vary depending on fish size and water temperature. When using Alka Seltzer Gold, typically one to two tablespoons will be used per gallon of water. MS-222 is typically used at a concentration of 50 mg/L. Smaller fish (fry, small parr) will be placed in the anesthetic solution in groups of ten or fewer while larger fish (large parr, smolts) will be added in groups of two. After groups of fish are placed in the anesthetic solution, they will be closely monitored and will be processed immediately after they have lost equilibrium but still have operculum movement. After processing, fish will be placed in aerated 5-gallon buckets containing fresh river water and allowed to recover until they exhibit normal behavior. Water in the buckets will be monitored to ensure that temperature remains within 2°C of the ambient river water and DO is above 5 mg/L. Water will be replaced and aerators used, as necessary, to maintain acceptable water quality.

Morphometric Measurements

After all juvenile Chinook salmon and *O. mykiss* greater than 50 mm FL are anesthetized, FL will be measured to the nearest mm and fish weighed to the nearest 0.01 gram (g). Juvenile Chinook salmon and *O. mykiss* that are less than or equal to 50 mm FL will only be anesthetized and FL measured to the nearest mm. After anesthetized fish have lost equilibrium, they will be placed on a wetted measuring board and FL measured to the nearest mm. After measuring, they will be placed on the scale in a tared weigh boat containing river water and weighed to the nearest 0.01 g. After processing, all fish will be either PIT tagged (see below) or immediately placed in a recovery bucket containing aerated fresh river water and Stress Coat (API Inc.) at a concentration of 1 mL/1 gallon of water.

Passive Integrated Transponder Tag

Juvenile Chinook salmon between 55 and 65 mm FL will be PIT tagged with 8 mm tags; fish larger than 65 mm FL will be PIT tagged using a 12 mm tag. Anesthetized fish will be measured and weighed, then injected with a PIT tag using a PIT tag injector. The needle of the PIT tag injector will be inserted posterior of the tips of the pelvic fins and to the left of the mid-ventral line and then the tag injected in the posterior direction. Alternatively, a micro-scalpel may be used to tag the fish in the same location. Prior to insertion, all PIT tags will be sterilized in Nolvasan (chlorhexidine diacetate) disinfectant, rinsed in reverse osmosis or distilled water, and scanned with a handheld PIT tag reader and the unique number recorded on the datasheet. The PIT-tagging instrument will also be sterilized between each fish by dipping in Nolvasan and rinsing in reverse osmosis or distilled water. Immediately after being PIT tagged, the fish will be placed in a recovery bucket containing aerated river water. The PIT-tagged fish will only be released once they have fully recovered from anesthesia and surgery (*i.e.*, are swimming normally and will avoid/swim away from a disturbance). The recovered fish will be released back into the study sites (control or restored backwater habitats). PIT-tagged fish will be re-captured in the fyke net(s) or during periodic beach seine sampling in the study sites. After the first batch of PIT-tagged fish have been released, all juvenile Chinook salmon captured during beach seining or in fyke nets will be scanned with a handheld PIT tag reader.

Genetic Tissue Sample

PIT-tagged juvenile Chinook salmon (55 mm or greater FL) will have a genetic tissue sample taken via either fin clip or swab while the fish is anesthetized during processing. A fin clip will consist of cutting a small piece of tissue from the upper caudal lobe using clean surgical scissors. Tissue size will be approximately one mm^2 for fish less than 65 mm and four mm^2 for fish greater than 65 mm FL. All scissors will be sterilized in a 20 percent bleach solution, rinsed in reverse osmosis or distilled water, and then rinsed in 70 percent ethanol between each use. Each fin clip will be placed in an individually labeled cryotube filled with 95 percent ethanol or on a piece of "rite in the rain" paper and placed in an individually labeled scale envelope. The cryotubes or scale envelopes will be labeled with the sample ID, collection location, date, fish species, and FL.

Genetic tissue samples from juvenile Chinook salmon will be analyzed by Genidaqs to determine the run of each fish (fall-run or spring-run). This will allow a more accurate estimate of the relative proportion of fall- and spring-run fish that are impacted by the study, and provides resource agencies with important information to better understand the temporal distribution of the two runs in the LYR. In addition, it allows for only fall-run Chinook salmon to be taken for lethal sampling for the growth studies described above, leaving captured spring-run Chinook salmon (as identified by the PIT tag code and associated genetic identification) to be released unharmed.

Humane Euthanasia

Juvenile Chinook salmon selected to be sacrificed for lipid content assays, otolith extractions, and stomach content analysis will be processed for length and weight and then euthanized using an overdose of MS-222. They would then be placed in individually labeled whirl-pacs and placed on ice prior to freezing in the lab.

1.3.4.7 Project Conservation Measures

Conservation measures are measures and practices adopted by a project proponent to reduce or avoid adverse effects that could result from project construction, maintenance, or operation. The following sections describe the conservation measures adopted for the proposed restoration activities and follow-up monitoring. These measures will be incorporated in construction documents (plans and specifications) prepared for the Project and will be contractually required of all construction contractors.

General Measures to Protect Water Quality

Subject to requirements of Section 402 of the federal Clean Water Act (CWA) and the National Pollutant Discharge Elimination System (NPDES) permitting process, all construction projects that disturb more than one acre of land are required to prepare and implement a Stormwater Pollution Prevention Plan (SWPPP). A SWPPP will be prepared by CFS. The restoration construction contractor(s) will be required to post a copy of the SWPPP at the Project site, file a notice of intent to discharge stormwater with the Regional Water Quality Control Board, and implement all measures required by the SWPPP. A Qualified SWPPP Practitioner (QSP) will be responsible for monitoring to ensure that the provisions of the SWPPP are effectively enforced. In the event of non-compliance, the QSP will have the authority to shut down the construction site or fine the responsible party or parties.

The SWPPP will include the following information and stipulations:

- A description of site characteristics, including runoff and drainage characteristics and soil erosion hazard.
- A description of proposed construction procedures and construction-site housekeeping practices, including prohibitions on discharging or washing potentially harmful materials into streets, shoulder areas, inlets, catch basins, gutters, or agricultural fields, associated drainage, or irrigation features.
- A description of measures that will be implemented for erosion and sediment control, including requirements to:
    - Conduct major restoration activities involving excavation and spoils haulage during the dry season, to the extent possible.
    - Conduct all restoration work in accordance with site-specific construction plans that minimize the potential for increased sediment inputs to storm drains and surface waters.
    - Grade and stabilize spoils sites to minimize erosion and sediment input to surface waters and generation of airborne particulate matter.
    - Implement erosion control measures as appropriate to prevent sediment from entering surface waters, agricultural water features, and storm drains to the extent feasible, including the use of silt fencing or fiber rolls to trap sediments and erosion control blankets on exposed slopes.
- A Spill Prevention and Response Plan (SPRP) that identifies any hazardous materials to be used during restoration work; describes measures to prevent, control, and minimize the spillage of hazardous substances; describes transport, storage and disposal procedures for these substances; and outlines procedures to be followed in case of a spill of a hazardous material. The SPRP will require that hazardous and potentially hazardous substances stored onsite be kept in securely closed containers located away from drainage courses, agricultural areas, storm drains, and areas where stormwater is allowed to infiltrate. It will also stipulate procedures, such as the use of spill containment pans, to minimize hazard during onsite fueling and servicing of construction equipment. Finally, the SPRP will require that the County be notified immediately of any substantial spill or release.
- A stipulation that restoration work will be monitored by a QSP to ensure that contractors are adhering to all provisions relevant to state and federal stormwater discharge requirements, and that the QSP will shut down the construction site in the event of noncompliance.

Water Quality Measures for In-water Restoration Work

In-water work, including all wetted channel and bank modifications, will be restricted to the minimum necessary to support Project success. In-water work will be limited to the dry season (July 15-September 30).

- The Proposed Action will comply with Section 401 of the CWA and obtain certification for construction-related activities to control sediment from entering the main river channel during restoration activities. To minimize risk from additional fine sediments, all trucks and equipment will be cleaned prior to arrival on site. Turbidity and aqueous and sediment total mercury levels will be monitored in accordance with Section 401 permit requirements.
- Stream bank impacts will be isolated and minimized to reduce bank sloughing. The banks will be stabilized following construction activities.
- All equipment working within the stream corridor will be inspected daily for fuel, lubrication, and coolant leaks; and for leak potentials (*e.g*., cracked hoses, loose filling caps, stripped drain plugs); and all equipment must be free of fuel, lubrication, and coolant leaks. Vehicles or equipment will be washed/cleaned only at off-site areas. All equipment will be steam cleaned prior to working within the stream channel to remove contaminants that may enter the river and adjacent lands. All equipment will be fueled and lubricated in a designated staging area located outside the stream channel and banks.
- Only heavy equipment with vegetable-based hydraulic fluid will work in the wetted channel to reduce the potential for water quality impacts to the Yuba River.
- All equipment entering the river will be steam cleaned before it is used elsewhere to minimize the chance of introducing New Zealand mud snails (*Potamopyrgus antipodarum*) to other water bodies.
- Fish and other aquatic organisms will be protected as described under Measures to Protect Biological Resources below.

1.3.4.7.1 Measures to Protect Biological Resources

The following measures will apply to all construction and maintenance activities:

Vegetation Protection Measures

In order to avoid and minimize adverse effects on riparian vegetation, the following guidelines will be observed:

- Before restoration work begins, the engineer and a qualified biologist will identify locations for equipment and personnel access and materials staging that will minimize riparian disturbance.
- Existing access points and roads will be used whenever possible in order to avoid disturbance to sensitive locations. The least sensitive areas will be used for parking, stockpiling, and staging areas and these areas will be clearly marked and restored following completion.
- During restoration activities, as much understory brush and as many trees as possible will be retained. The emphasis will be on retaining shade-producing and bank-stabilizing vegetation.
- Impacts on heritage-sized trees (*i.e.*, greater than 24 inches [61 cm] diameter breast height) will be avoided to the extent practicable through use of 30-foot, no disturbance buffers. If a heritage-sized tree needs to be removed, it will be replaced at a 10:1 ratio.

- When chainsaws are used to remove riparian vegetation, saws compatible with vegetable-based bar oil will be used.
- When heavy equipment is required, unintentional soil compaction will be minimized by using equipment with a greater reach or using low-pressure tire equipment to distribute weight over a greater area. Disturbed soils that have become compacted will be decompacted when work is completed.
- Any disturbed and decompacted areas outside the restoration area will be revegetated with locally sourced native stock in an appropriate species palette.
- Sensitive vegetation (*e.g*., elderberry shrubs) in the near vicinity of restoration areas will be flagged or fenced.
- All contractors and equipment operators will be given instructions to avoid impacts and will be made aware of the ecological value of the site.

Salmonid Protection Measures

To reduce the likelihood of adverse impacts on salmonids that use the LYR corridor, in-water construction, including both stream bank and channel bed construction, will be limited to the dry season (July 15-September 30) and outside of the critical period for salmonids in the LYR.

<u>Procedures to Protect Salmonids during In-Water Work</u>: The majority of work will occur outside of the LYR main channel. In-water work in the LYR main channel will involve the grading and excavation of material to create connections to the main channel for seasonal and perennial side channels and alcove channels. Grading will be performed on floodplain terraces adjacent to the main channel in order to lower their elevation, thereby allowing them to inundate at lower river flows. In-water work will also occur in the perennially-inundated backwater and isolated ponds at the downstream end of the Action Area. In these areas, substrate will be added to fill in the ponds and backwater to create the Backwater Channel.

In addition, the configuration of the channel areas that currently connect the ponds and backwater may be changed. The backwater and isolated pond complex is groundwater-fed and only connects to the LYR main channel at the downstream end when flows are approximately 2,000 cfs in the main channel. Surface water enters the upstream end of the backwater complex when main channel flows are approximately 10,000 cfs. The length of the groundwater-fed complex where in-water work will occur is approximately 360 m (1,181 feet) long at its maximum extent when it has a downstream surface connection to the main channel. However, during the summer it typically becomes isolated and is only 230 m (755 feet) long.

The listed fish species that may be present during the in-water construction (15 July-30 September) are juvenile CCV steelhead and CV spring-run Chinook salmon, with juvenile steelhead more likely to be present as they are present year-round in the Yuba River (CFS 2021) and have been observed in the main channel in the Action Area during all months surveyed (January to October; Table 9). Juvenile CV spring-run Chinook Salmon may be present in very low densities as the majority of them have out-migrated from the Yuba River by the end of June, but it is possible that some juveniles demonstrating the yearling life history strategy may be present (CFS 2021). However, juvenile Chinook salmon have not been observed at any of the pre-project survey locations from June-October (Table 9.). Backwater pools are not considered suitable habitat for adult salmonids that may be present in the river during the construction period; however, if adults are observed, work will cease until the fish have left the Action Area.

Table 9. Pre-project snorkel survey juvenile Chinook salmon and presence/absence data compiled from surveys conducted in 2017 (May), 2018 (Feb, April, May), and 2020 (January-March, May-October). The Control Backwater was only surveyed in 2020 (from CFS)

Habitat	Pre-project Snorkel Observations									
	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct
Juvenile Chinook Salmon										
Main Channel	■	■	■	■	■					
Project Backwater				■	■					
Control Backwater										
Juvenile/sub-adult *O. mykiss*										
Main Channel	■	■	■	*	■	■	■	■	■	■
Project Backwater										
Control Backwater	■	■				■	■			

*****_O. mykiss_ were observed during April 2018 outside of the official survey transects.

CFS conducted monthly pre-project snorkel surveys during February, April, and May in 2018 and January-October (except for April) in 2020 to characterize baseline fish communities prior to restoration and determine the presence or absence of listed fish species in these locations. Juvenile salmonids have been observed in the isolated ponds upstream of the backwater, but the ponds primarily contain Sacramento Pikeminnow (*Ptychocheilus grandis*), Sacramento Sucker (*Catostomus occidentalis*), sunfish (family: *Centrarchidae*), and American Bullfrogs (L*ithobates catesbeianus*) (CFS, unpublished data). Juvenile Chinook salmon were observed in the backwater during the spring when flows were sufficient to create a surface connection with the main channel. However, juvenile Chinook salmon have not been observed in the backwater during the Project in-water work months (July-September Table 9). *O. mykiss* have not been observed in the area of the Project backwater (Table 9).

A three-tiered approach will be used to minimize the adverse effects on fish during in-stream construction work. The three approaches are the following: 1) construction approach, 2) fish relocation through herding, and 3) fish capture and relocation. Ideally, only the first technique will be used as it will be the easiest to implement and is expected to have the lowest impact to fish, as they will not be subjected to the stress of capture, handling, or transport. However, it is possible that a combination of the methods may be necessary during the in-water work (Figure 4) to complete the restoration and avoid adverse effects. The three methods are discussed in detail below.

Figure 4. The area within the backwater complex where fish relocation may be necessary during construction of the Proposed Action (from CFS 2021).

<u>*Construction Approach*</u>: The construction approach will consist of construction beginning at the upstream-most part of the Project and working its way downstream, allowing fish to move volitionally downstream and away from the impact area. The majority of in-water work will involve creating a side channel through the existing ponds and backwater. To accomplish this, prior to any filling or excavation, an excavator would create connector channels between the isolated ponds and the backwater and between the backwater and the main channel, to allow for fish egress. Once suitable downstream egress has been established, in-stream construction will begin at the most upstream section of the channel, and work progressively downstream and across the channel. This is expected to allow fish to move progressively downstream and away from the construction impacts and eventually into the LYR main channel. The listed fish species that may be present are juvenile CV spring-run Chinook salmon that are demonstrating the yearling life history strategy from 76-130 mm (3-5 inches) FL and juvenile CCV steelhead from 50-300 mm (2-12 inches) FL. Juvenile Chinook salmon and steelhead are highly mobile and would be expected to easily move downstream and away from the impact area when a suitable egress route exists. Juvenile Chinook salmon and steelhead are not likely to be present in the ponds or the backwater during the summer based on the lack of observations over the summer in

these locations during pre-project snorkel surveys. Once work proceeds past an area, fish will be able to migrate upstream to use the newly created habitat.

If for some reason it is not feasible to use heavy equipment to create a downstream egress route prior to starting in-water work, fish relocation will be performed to prevent fish injury and mortality and minimize disturbance.

Fish Capture and Relocation: If the construction approach is not feasible, fish capture and relocation will be implemented to remove fish from the in-water work area. The following guidelines will apply to fish capture and relocation.

- Before fish relocation begins, a qualified fisheries biologist will identify the most appropriate release location(s). Release locations will have water temperatures within 2°C of the capture location, offer suitable habitat for released fish, and will be selected to minimize the likelihood that fish will re-enter the work area.
- The method used to capture fish will depend on the nature of the work site and will be selected by a qualified fisheries biologist who is experienced with fish capture and handling. Areas of complex habitat may require the use of electrofishing equipment, whereas in other areas fish may be captured through seining or dip netting. Electrofishing will only be performed by properly trained personnel following NMFS guidelines (2000). Electrofishing will only be performed if seining and/or dip netting is not feasible.
- Handling of salmonids will be minimized. When it is necessary, personnel will only handle fish with wet hands or nets.
- Fish will be held temporarily in cool, shaded water in a five-gallon bucket with a lid or in a mesh live-car placed in an appropriate location in the river. Overcrowding will be avoided by ensuring that no more than 25 fish are be kept in each five-gallon bucket and limiting each live-car to 50 fish. Aeration will be provided with a battery powered external bubbler. Fish will be protected from jostling and noise and will not be removed from the bucket until the time of release. The water temperature in each bucket will be monitored and partial water changes or the addition of ice and stress coat will be conducted as necessary to maintain a stable water temperature (within 2°C of initial water temperature). Fish will not be held for more than a half hour. If water temperature reaches or exceeds NMFS limits, fish will be released and relocation operations will cease.
- If fish are abundant, capture will pause periodically to allow release and minimize the time fish are held in containers.
- Fish will not be anesthetized or measured. However, they will be visually identified to species level and year classes will be estimated and recorded to support annual take reporting.
- When feasible, initial fish relocation efforts will occur several days prior to the scheduled start of construction and the fisheries biologist will perform a survey on the same day before construction.
- Reports on fish relocation activities will be submitted to Californian Department of Fish and Wildlife (CDFW) and NMFS in a timely fashion.
- If mortality during relocation exceeds two percent, relocation will cease and CDFW and NMFS will be contacted as soon as feasible.

2. ENDANGERED SPECIES ACT: BIOLOGICAL OPINION AND INCIDENTAL TAKE STATEMENT

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

2.1. Analytical Approach

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

This biological opinion also relies on the regulatory definition of "destruction or adverse modification," which "means a direct or indirect alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species" (50 CFR 402.02).

The designations of critical habitat for CV spring-run Chinook salmon and CCV steelhead use the term primary constituent element (PCE) or essential features. The 2016 final rule (81 FR 7414; February 11, 2016) that revised the critical habitat regulations (50 CFR 424.12) replaced this term with physical or biological features (PBFs). The shift in terminology does not change the approach used in conducting a "destruction or adverse modification" analysis, which is the same regardless of whether the original designation identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

The ESA Section 7 implementing regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the final rule revising the definition and adding this term (84 FR 44976, 44977; August 27, 2019), that revision does not change the scope of our analysis, and in this opinion we use the terms "effects" and "consequences" interchangeably.

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

- Evaluate the rangewide status of the species and critical habitat expected to be adversely affected by the proposed action.
- Evaluate the environmental baseline of the species and critical habitat.
- Evaluate the effects of the proposed action on species and their critical habitat using an exposure–response approach.
- Evaluate cumulative effects.
- In the integration and synthesis, add the effects of the action and cumulative effects to the environmental baseline, and, in light of the status of the species and critical habitat, analyze whether the proposed action is likely to: (1) directly or indirectly 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; or (2) directly or indirectly result in an alteration that appreciably diminishes the value of critical habitat as a whole for the conservation of a listed species.
- If necessary, suggest a reasonable and prudent alternative to the proposed action.

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. 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' "reproduction, numbers, or distribution" for the jeopardy analysis. 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 function of the PBFs that are essential for the conservation of the species.

Within the Action Area, CV spring-run Chinook salmon, and CCV steelhead are known to occur. The presence of the Southern Distinct Population Segment (sDPS) of North American green sturgeon in the action area is prevented by the presence of Daguerre Point Dam, although sDPS green sturgeon are known to be present immediately below the dam, which is approximately 3.5 miles downstream of the Project's Action Area. Sacramento River winter-run Chinook salmon do not occur within the Action Area. The Action Area also contains designated critical habitat for CV spring-run Chinook salmon and CCV steelhead. The Action Area does not contain designated critical habitat for either Sacramento River winter-run Chinook salmon or sDPS green sturgeon. Tables 10 and 11 describe the status of CV spring-run Chinook salmon and CCV steelhead, and the designated critical habitats within the Action Area of the Project.

Table 10. Description of species, current Endangered Species Act (ESA) listing classifications, and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Central Valley spring-run Chinook salmon ESU	Threatened, 70 FR 37160; June 28, 2005	According to the NMFS 5-year species status review (NMFS 2016b), the status of the CV spring-run Chinook salmon ESU, until 2015, has improved since the 2010 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk. Monitoring data showed sharp declines in adult returns from 2014 through 2018 (CDFW 2018).
California Central Valley steelhead DPS	Threatened, 71 FR 834; January 5, 2006	According to the NMFS 5-year species status review (NMFS 2016a), the status of CCV steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was in danger of becoming endangered. Most natural-origin CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead.

Table 11. Description of Critical Habitat, Listing, and Status Summary.

Critical Habitat	Designation Date and Federal Register Notice	Description
Central Valley spring-run Chinook salmon ESU	70 FR 52488: September 2, 2005	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 and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for CV spring-run Chinook salmon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.
California Central Valley steelhead DPS	70 FR 52488, September 2, 2005	Critical habitat for CCV steelhead includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for CCV steelhead critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.2.1. Estimated Abundances of CV spring-run Chinook salmon and CCV steelhead

Species-specific status information, including abundance estimates by life stage and hatchery or naturally produced fish, is discussed in more detail below. Estimates of adult abundance often come from annual spawning surveys or counts at dams, weirs, or fish ladders, and may or may not differentiate natural-origin from hatchery-origin fish. In many cases, estimates of naturally produced out-migrating juveniles are not available from monitoring data, and are instead estimated from adult spawner abundance, any known estimate of spawner fecundity, and average egg-to-smolt survival rates. For hatchery-origin juvenile salmonids, we use hatchery production goals to estimate abundance.

2.2.1.1 Central Valley spring-run Chinook salmon

To estimate annual abundance of adult spawners (natural- and hatchery-origin), we calculate the average of the most recent three years of adult spawner counts (2017 through 2019) from surveys conducted by CDFW (GrandTab 2021). The average total abundance for CV spring-run Chinook salmon is 6,672 adult spawners. It should be noted that this estimate does not include adult spring-run Chinook salmon spawners from the Feather River. However, the Feather River Hatchery implements a tagging program for early-arriving (phenotypic spring-run) Chinook salmon, which allows for the identification spring-run Chinook salmon broodstock when they return to spawn in the fall. Fish ascending the fish ladder between April 1 and June 30 are tagged and released back into the Feather River. The number of phenotypic spring-run Chinook salmon tagged at the Feather River Hatchery provides an annual estimate of adult spawners in the Feather River. This estimate also includes adults that are used as hatchery broodstock, since only tagged individuals will be used during spawning in the fall. The average number of adult spring-run Chinook salmon tagged at the Feather River Hatchery from 2017-2019 is 3,304. Therefore, the total average adult escapement (including Feather River adults) for spring-run Chinook salmon is 9,976 (Table 12).

The expected natural-origin juvenile production estimate was developed by applying the average fecundity of 4,161 eggs per female (CDFG 1998) to the estimated 4,988 females returning (half of the most recent three-year average of spawners), and applying an estimated survival rate from egg to smolt of 10 percent.

The Feather River Hatchery is the only hatchery that produces Central Valley spring-run Chinook salmon (with the exception of the San Joaquin Salmon Conservation and Research Facility). Therefore, the annual number of hatchery-origin spring-run Chinook salmon produced average number of juveniles released from the Feather River Hatchery during recent years (CDFW and DWR 2018).

Table 12. Central Valley spring-run Chinook salmon Abundance Estimates.

Life Stage	Average Annual Abundance Estimates
Average Adult Escapement (2017-2019)	9,976
Expected Natural-origin Juvenile Production	2,075,507
Average Annual Hatchery Releases from Feather River Hatchery (2006-2017)	2,025,571

2.2.1.2 CCV Steelhead

To estimate annual abundance for adult spawners (natural- and hatchery-origin) we use the average of the estimated run sizes for the most recent three years (2017-2019) from populations with available survey data (Scriven *et al*. 2018, additional unpublished data provided by the NMFS Southwest Fisheries Science Center. It is important to note that these estimates do not include data from a number of watersheds where steelhead are known to be present, and therefore likely represent an underestimate of adult abundance for the DPS.

Both adult and juvenile abundance data are limited for this DPS. While we currently lack data on naturally produced juvenile CCV steelhead, it is possible to make rough estimates of juvenile abundance from the available adult return data. Juvenile CCV steelhead abundance estimates come from the escapement data for adults. However, the sum of the annual hatchery adult broodstock goals (1,820 adults; CDFW unpublished data, USFWS 2011) have been subtracted from the total to account for the separate juvenile hatchery production estimate.

For the species, fecundity estimates range from 3,500 to 12,000, and the male to female ratio averages 1:1 (Pauley *et al*. 1986). By applying a conservative fecundity estimate of 3,500 eggs to the expected escapement of females, 16.9 million eggs are expected to be produced annually. With an estimated survival rate of 6.5 percent (Ward and Slaney 1993), the DPS should produce roughly 1,100,418 natural-origin outmigrants annually (Table 13).

The sum of expected annual releases from all of the hatchery programs is used to estimate the abundance of out-migrating hatchery-origin juvenile CCV steelhead (CDFW unpublished data, USFWS 2011; Table 13).

Table 13. California Central Valley steelhead Abundance Estimates.

Life Stage	Average Annual Abundance Estimates
Average Adult Escapement (2017-2019)	11,494
Natural-origin Juveniles	1,100,418
Hatchery-origin Juveniles	1,730,000

2.2.2. 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 and Cayan 1995). Projected warming is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9 degrees Fahrenheit [°F]), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006).

CV spring-run Chinook salmon adults are vulnerable to climate change, because they over-summer in freshwater streams before spawning in autumn (Thompson *et al*. 2011). Spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change. Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile 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).

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

2.3. Action Area

"Action area" means all areas to be affected directly or indirectly by the Federal action and not merely the immediate area involved in the action (50 CFR 402.02).

The Action Area for the Project's elements includes the footprint of instream construction work and the area downstream of this, where instream construction activities can temporarily decrease water quality. The effects of increased turbidity will attenuate downstream as suspended sediment settles out of the water column. Instream projects with a larger footprint than the Project have created turbidity plumes of 25-75 nephelometric turbidity units (NTUs) extending up to 1,000 feet (304.8 m) downstream as a result of instream construction activities (NMFS 2006). Therefore, a conservative definition of the Action Area for restoration projects with instream activities includes the project boundary and the segment of river extending from the edge of the Proposed Project boundary to 1,000 feet (304.8 m) downstream. The Action Area for this Project also includes adjacent biological monitoring control sites that are located both upstream and downstream of the Project's construction footprint. These sites will be affected by the Project during pre- and post-project monitoring activities to determine restoration effectiveness (CFS 2020). Therefore, the Action Area for the Proposed Action includes the reach of the LYR mainstem from the upstream control site to the downstream boundary and extending downstream for 1,000 feet and the backwater control site (downstream of the Project grading footprint on river left; Figure 5). This is the area in which the Project could result in effects on federally listed species. Figure 5 shows the Action Area boundary and the restoration grading extent.

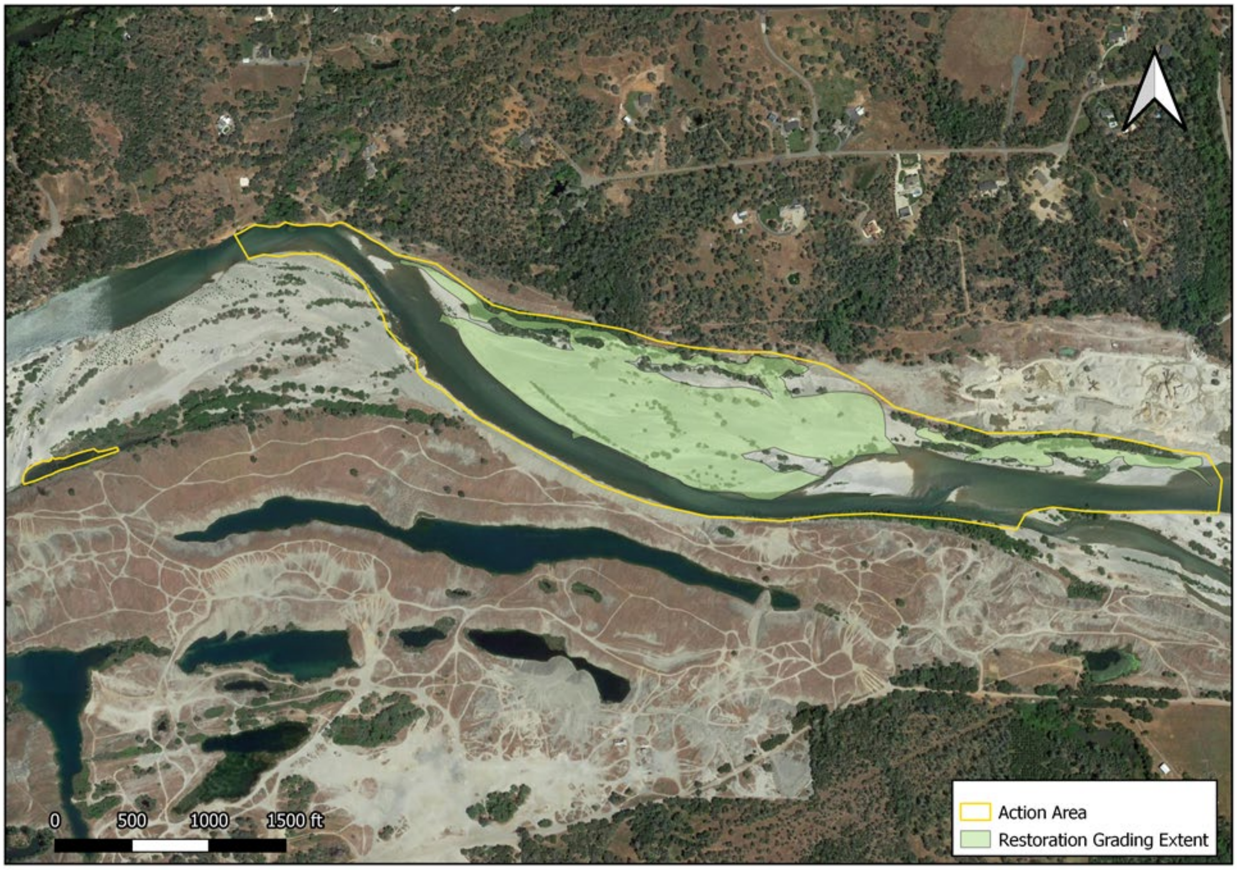

Figure 5. The Action Area for the Proposed Project.

2.4. Environmental Baseline

The "environmental baseline" refers to the condition of the listed species or its designated critical habitat in the Action Area, without the consequences to the listed species or designated critical habitat caused by the proposed action. 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 consultations, and the impact of State or private actions which are contemporaneous with the consultation in process. The consequences to listed species or designated critical habitat from ongoing agency activities or existing agency facilities that are not within the agency's discretion to modify are part of the environmental baseline (50 CFR 402.02).

2.4.1. Local and Regional Characteristics

The Yuba River as a tributary to the Feather River in the northern portion of the (CCV and drains an approximately 1,300 square mile (mi^2) (3,367 square kilometer [km^2]) watershed. The Yuba River has three forks (north, middle, and south), which each originate in the Sierra Nevada mountain range. Elevations in the watershed range from 9,148 feet (2,788 meters [m]) on Mt. Lola at the crest of the Sierra Nevada to 60 feet (18 m) at the confluence with the Feather River.

The Middle Fork flows into the North Fork downstream of New Bullards Bar reservoir, forming the main Yuba River, which then flows into Englebright Reservoir. The South Fork also flows into Englebright Reservoir. The LYR begins below Englebright Dam and flows for approximately 24 miles before joining the Feather River near Marysville. The LYR has two major tributaries: Deer Creek, which flows in approximately 1 mile below Englebright Dam; and Dry Creek, which flows in downstream of Long Bar near Hammon Grove Park. The watershed receives a portion of its annual precipitation as snow at higher elevations (80 inches in the upper watershed), with the remainder falling as rain (approximately 20 inches) at lower elevations. The impacts of forecasted climate change will alter the nature of the seasonal runoff pattern, reducing the input of snowmelt as a source of water input for the upper watershed, with precipitation shifting from snow to rain in the upper watershed.

Typical of many Central Valley rivers, historic gold and gravel mining following European expansion into the west, greatly altered geomorphic and hydraulic conditions under which salmonids evolved. Gold was discovered on the Yuba River in 1848, and the subsequent influx of thousands of miners forever changed the physical attributes of the Yuba River, adversely impacting native species and displacing indigenous peoples. Relevant changes include:

- *Vast influx of hydraulic mining sediment*: It is estimated that from 1849-1909, the Yuba River received roughly 685 million cubic yards (yd^3) of sediment, more than the Upper Feather, Bear, and American rivers combined (Gilbert 1917). This influx caused such severe aggradation of the Yuba River that by 1868 the channel bed had risen 20 feet and was higher than the streets of Marysville (Ayres Associates 1997). Flooding in Marysville in 1875 prompted the prohibition of in-stream disposal of hydraulic mining sediments.
- *Shifting and confinement of the river's course*: In the early 1900s, the California Debris Commission sanctioned the re-alignment of the lower Yuba River to the north of the historic alignment and the construction of large linear "training walls" consisting of steeply mounded tailings piles in the center and along both banks of the straightened river corridor. The training walls were piled to substantial heights above the 100-year flood elevation and with dramatically varying top widths of up to 500 feet (AECOM 2015). The makeshift training walls were intended to laterally confine the river to allow for additional widespread dredging operations (gold mining) of the naturally occurring and hydraulic mining derived sediments deposited in the valley.
- *River regulation and coarse sediment control*: In 1906, Daguerre Point Dam was constructed as a partial sediment barrier and base-level control point. Englebright Dam was constructed in 1941, and was designed to keep upstream hydraulic mining debris out of the lower river (YCWA 2017). In 1971, New Bullards Bar Dam was built to control mining debris and generate power (Pasternack 2009). As a result, the influx of sediment and the major flood events have both been significantly altered, affecting the hydrologic regime and the movement of sediment in the system. Large woody material passes over Englebright Dam, but is often greatly weathered or simplified from residence time in the reservoirs upstream and through passage over the dam (*i.e.*, canopy and rootwad materials removed). This most likely reduces the ability of key pieces to lock in place within the LYR channel.

Despite the presence of several significant dams in the upper watershed (*e.g.*, New Bullards Bar and Englebright Dam), the lower Yuba River still experiences moderate and major floods capable of inducing natural and significant geomorphic changes. This is due to the run-of-the-river dam characteristics of these structures, where high flood flows will overtop the dam crest.

2.4.2. Mercury Contamination

During historical gold mining within the Yuba River watershed, more than 8 million pounds of mercury were lost to the environment (Hunerlach *et al.* 2004). Much of the mercury left over from the mining era is contained in sediment held behind Englebright Dam and Daguerre Point Dam.

Methylmercury is the form of mercury that is toxic to biota and which can bioaccumulate in aquatic organisms. In the environment, methylmercury can be produced from the soluble fraction of the inorganic mercury by naturally occurring anaerobic bacteria. However, it is likely that only a very small fraction of the total mercury associated with gold mining sediments in the Yuba River is actually 'reactive' and available to bacteria for methylation (Singer *et al.* 2016). Although most of the mercury is not biologically available, enough has methylated in Englebright Lake that it is bio-accumulating in the larger predatory fish (USACE 2014).

Methylmercury can be removed from shallow surface waters through photo degradation, a process by which methylmercury is converted to less toxic inorganic mercury by the sun's ultraviolet light (USGS 2014). However, because mercury in aquatic environments preferentially partitions to soil, sediment, and suspended matter (*i.e.*, the dissolved mercury concentration is typically far lower than the concentration in soil, sediment, and suspended matter), most of the mercury in the water column is removed not by reduction to the elemental species, but by sedimentation of the particles to which divalent mercury and methylmercury are bound. As a result of this sedimentation process, sediment in the Yuba River exhibits high levels of mercury (CFS 2016).

2.4.3. Existing Conditions

CCV anadromous salmonids in the Yuba River do not have access to their historic habitat in the upper watershed. Historically, the upper watershed was an area where CV spring-run Chinook salmon adults held over the summer, spawned, and juveniles reared. CCV steelhead also used the upper watershed for rearing and spawning. The upper watershed provided cool water for CV spring-run Chinook salmon to hold over the summer, as well as ample spawning habitat. CV anadromous salmonids currently are unable to move upstream of Englebright Dam. The Yuba River downstream of Daguerre Point Dam has the potential to get very warm in the summer. It is likely that the water in the Yuba River downstream of Daguerre Point Dam will get warmer over time, due to changes in the climate.

In the lower portion of the LYR, fish habitat is impaired due to mining, water withdrawals, and other modifications to the river. In the lowest reaches of the LYR water temperatures can be unsuitable for salmonids. In the upper reaches of the LTR, water temperatures are cooler due to tailwater releases from reservoirs. For these reasons, restoration and creation of holding, spawning, incubation, and rearing habitat in the upper portion of the LYR is very important for salmonid persistence and recovery.

The Action Area for the proposed Project has been severely altered. Englebright Dam interrupts the movement of sediment that would normally create spawning habitat in this area of the Yuba River. In addition, mechanical dredger mining has occurred in the area. All of these activities have significantly modified the salmonid habitat in the Action Area. The LYR downstream of Highway 20, including within the Action Area, is confined by massive cobble and gravel deposits derived from hydraulic and dredge mining activities ("training walls") resulting in a relatively simple river corridor dominated by a single main channel and large cobble-dominated bars, with little riparian and floodplain habitat. Many areas within the LYR's historic corridor, including within the Action Area, are now hydrologically disconnected from the main channel during more frequent flood flows (1.5-5 year recurrence interval) due to anthropogenic impacts including, but not limited to, the construction of training walls and deposition of mining tailings in the channel that reduce floodplain availability, and reduction in flood flows due to flow regulation by the upstream reservoirs (cbec *et al.* 2010).

The LYR within the Action Area is comprised largely of a large gravel bar on the north side of the river and the main channel of the LYR, which has relatively little complexity. Within the Action Area, the main channel is constrained on river left by a large training wall that was built in the early 1900s to realign the river to the north and confine it to facilitate gold dredge mining to the south in the goldfields. On river right, at the upstream end of the Project's grading footprint, there is a smaller training wall maintained by SRI to minimize flooding of their aggregate operation. Despite the historic impacts to fish habitat, the Action Area still supports some rearing of juvenile Chinook salmon, CCV steelhead, and other native fish species (CFS 2021). Chinook salmon redds have also been observed in the LYR main channel within the Action Area (CFS, unpublished data).

In light of the potential use of habitat by listed salmonids in the Action Area, if spawning and rearing habitat were to be improved, gravel augmentation in the Yuba River Englebright Dam Reach, downstream to the confluence with Deer Creek was identified in the NMFS Recovery Plan for Central Valley Chinook Salmon and Steelhead (NMFS 2014) as a recovery action. That plan also identified the creation and restoration of side channel habitat in the Yuba River as a recovery action.

2.4.4. CV spring-run Chinook salmon and CCV steelhead and their Critical Habitat in the Action Area

The Yuba River within the Action Area is used primarily as a migration corridor for adult and juvenile CV spring-run Chinook salmon and CCV steelhead. However, some use by juvenile salmonids for rearing has been observed during monitoring activities (CFS 2021).

Juvenile salmonid rearing habitat is limited within the Action Area for the proposed Project. Currently, rearing habitat is restricted to edge habitats along the river's margins. Within these areas, there is little large woody material, and few features that would provide shelter from high flow velocities, create feeding zones, or provide cover from predators. Partly due to lost sediment supply, the river channel has incised over the last 75 years, leading to steeper banks, a reduction in the availability of edge habitat, and the abandonment of a relic side channel on the north bank.

The PBFs of critical habitat for CV spring-run Chinook salmon and CCV steelhead present in the Action Area are freshwater rearing habitat, freshwater migration corridors, and spawning habitat. Instream habitats within the LYR have been modified by anthropogenic actions, such as agriculture, gravel and gold mining, water impoundments, increased water diversions, decreased instream flows, and training walls (levees). These major factors, as well as other events, have led to the deterioration of riparian and aquatic habitat conditions in the Action Area. As described above, the LYR, including within the Action Area, has been converted from a complex multi-channel system to a single, incised and constricted channel, with a relatively narrow floodplain.

However, compared to many other Central Valley rivers, the LYR is less constricted and still contains alluvial river attributes including large gravel bars (Wyrick and Pasternack 2012). The LYR within the Action Area is dominated by a floodplain and side channels that only inundate at extreme high flows, with a few perennially inundated backwater pools at the downstream end of remnant side channels that are sustained via subsurface flow. The backwater pool within the Project's grading footprint is perennially disconnected at its downstream end with the main channel; juvenile Chinook Salmon are only able to access it when flows are sufficient to create a surface flow connection with the main channel during the rearing period. Infrequent and short-duration inundation onto historic floodplains due to incision provides little opportunity for juvenile salmonids to access seasonally inundated terrestrial vegetation and off-channel areas in the Action Area, and rearing habitat is generally considered a limiting factor in the LYR (Yoshiyama *et al.* 1996; Lindley *et al.* 2007). Instream cover is also sparse within the Action Area, except along the narrow riparian corridor at the river margins. These narrow margins provide some instream woody material and overhead cover provided by low-growing riparian vegetation.

The LYR within the Action Area is used as a migration corridor by both adult and juvenile CV spring-run Chinook salmon and CCV steelhead. Spring-run Chinook salmon have been documented to hold for an extended period of time in the pool below Daguerre Point Dam before migrating upstream in September to spawn.

Riffles and glides used by salmonids for spawning occur throughout the LYR main channel within the Action Area. Chinook salmon and steelhead have been documented spawning in the LYR within the Action Area (Yuba RMT 2013). The majority of the early spawning Chinook salmon (September to mid-October) spawn in reaches above Daguerre Point Dam and are believed to be spring-run. This is supported by acoustic tracking data of tagged fish (Yuba RMT 2013). The majority of this early Chinook salmon spawning activity occurs upstream of the Highway 20 bridge (Yuba RMT 2013). However, some redds have been observed in September within the Action Area and are likely to be from spring-run Chinook salmon (Yuba RMT 2013). Steelhead redds have also been observed within or adjacent to the Action Area between January and April (Yuba RMT 2013). The Action Area overlaps with the downstream end of the Parks Bar reach which is one of the two LYR reaches where the majority of steelhead spawning occurs (Yuba RMT 2013). In spring 2020, a steelhead redd was observed in the riffle immediately downstream of the beaver dam that demarcates the downstream end of the Control Backwater site that will be surveyed during effectiveness monitoring (CFS, unpublished data).

2.4.5. Climate Change

In contrast to the conditions for other Central Valley rivers, climate change may not have as much of an impact on salmonids in the LYR downstream of Englebright Reservoir (YCWA 2010b). Presently, the lower Yuba River is one of the few Central Valley tributaries that consistently has suitable water temperatures for salmonids throughout the year. LYR water temperatures generally remain below 58°F year-round at the Smartsville Gage (downstream of Englebright Dam), and below 60°F year-round at Daguerre Point Dam (YCWA *et al.* 2007). At Marysville, water temperatures generally remain below 60°F from October through May, and below 65°F from June through September (YCWA *et al.* 2007). However, in dry years temperatures may become warmer than the optimum range for salmonids, particularly in the lower section of the LYR.

According to YCWA (2010), the LYR is expected to continue to provide the most suitable water temperature conditions for anadromous salmonids when compared to other Central Valley rivers, even if there are long-term climate changes, due to specific physical and hydrologic factors. For example, New Bullards Bar Reservoir is a deep, steep-sloped reservoir with ample cold-water pool reserves. Throughout the period of operations of New Bullards Bar Reservoir (1969 through present), which encompasses the most extreme critically dry year on record (1977), the cold-water pool in New Bullards Bar Reservoir never was depleted. Since 1993, cold water pool availability in New Bullards Bar Reservoir has been sufficient to accommodate year-round utilization of the reservoir's lower level outlets to provide cold water to the LYR. Even if climate conditions change, New Bullards Bar Reservoir still will have a very substantial cold water pool each year that will continue to be available to provide sustained, relatively cold flows of water into the LYR during the late spring, summer and fall of each year (YCWA 2010a).

2.5. Effects of the Action

Under the ESA, "effects of the action" are all consequences to listed species or critical habitat that are caused by the proposed action, including the consequences of other activities that are caused by the proposed action (see 50 CFR 402.02). A consequence is caused by the proposed action if it would not occur but for the proposed action and it is reasonably certain to occur. Effects of the action may occur later in time and may include consequences occurring outside the immediate area involved in the action (see 50 CFR 402.17). In our analysis, which describes the effects of the proposed action, we considered the factors set forth in 50 CFR 402.17(a) and (b).

The effects of the Proposed Action include effects on listed species and their critical habitat. Short-term effects, which are caused primarily by restoration construction activities, include potential disturbance or harassment of fish from gravel augmentation, noise, and degradation of water quality from increased suspended sediment and turbidity, and potential mortality or physiological stress from spills of toxic substances. Long-term effects resulting from restoration operations include effects related to habitat modification and monitoring actions.

Table 14 lists all potential effects to CV spring-run Chinook salmon, CCV steelhead, and their designated critical habitat related to construction actions and post-construction monitoring activities. All effects related to the proposed action are discussed below in detail.

Table 14. Potential effects of activities associated with the Project on CV spring-run Chinook salmon, CCV steelhead, and their designated Critical Habitat within the Action Area.

Activity	CV spring-run Chinook salmon	CV-spring run Chinook salmon Critical Habitat	CCV steelhead	CCV steelhead Critical Habitat
Construction activity effects				
Sediment and turbidity	SA	SMA	SMA	SMA
Mercury	SMA	SMA	SMA	SMA
Contaminants	SMA	SMA	SMA	SMA
Noise	SMA	SMA	SMA	SMA
Modification of physical habitat				
Bank, bar, and channel modification	SMA, LTB	SMA, LTB	SMA, LTB	SMA, LTB
Fish Relocation	SA	SMA	SA	SMA
Restoration effectiveness monitoring	SA, LTB	LTB	SA, LTB	LTB

SMA = short-term, minimal adverse effect

SA = short-term, adverse effect

LTB = long-term beneficial effect

2.5.1. Sediment and Turbidity

Construction activities related to restoration construction actions will temporarily disturb soil and riverbed sediments as well as riparian vegetation, resulting in the potential for temporary increases in turbidity and suspended sediments in the LYR within the Action Area. Restoration-related increases in sedimentation and siltation above the background level could potentially affect fish species and their habitat by reducing embryo and juvenile survival, interfering with feeding activities, causing breakdown of social organization, and reducing primary and secondary productivity. The magnitude of potential effects on fish will depend on the timing and extent of sediment loading and flow in the river before, during, and immediately following construction.

Impacts to CV spring-run Chinook salmon and CCV steelhead will be minimized by conducting all in-water restoration activities during the dry season between July 15 and September 30. The number of juvenile salmonids potentially residing in the Action Area during in-water restoration is expected to be very low because of the time of year and low quality of existing habitat (CFS 2021). Individual fish that encounter increased turbidity or sediment concentrations would be expected to move laterally, downstream, or upstream of the affected areas to avoid the plume. For juveniles, this may increase their exposure to predators if they are forced to leave protective habitat. Turbidity plumes would be expected to affect only a portion of the channel width and extend up to 1,000 feet downstream of the Project's grading footprint. Turbidity will be monitored in accordance with the Section 401 Water Quality Certification for the Project and if turbidity exceeds the thresholds identified in the certification, work will cease until turbidity returns to background levels.

For those fish that are present and are exposed to turbidity plumes, the higher concentrations of suspended sediment can have effects on salmonids. The severity of these effects depends on the sediment concentration, duration of exposure, and sensitivity of the affected life stage. Based on the types and duration of proposed in-water construction methods, short-term increases in turbidity and suspended sediment may disrupt feeding activities or result in avoidance or displacement of fish from preferred habitat. Juvenile salmonids have been observed to avoid streams that are chronically turbid (Lloyd 1987) or move laterally or downstream to avoid turbidity plumes (Sigler *et al.* 1984). Sigler *et al.* (1984) found that prolonged exposure to turbidities between 25 and 50 NTUs resulted in reduced growth and increased emigration rates of juvenile coho salmon and steelhead compared to controls. These findings are generally attributed to reductions in the ability of salmon to see and capture prey in turbid water (Waters 1995). Chronic exposure to high turbidity and suspended sediment may also affect growth and survival by impairing respiratory function, reducing tolerance to disease and contaminants, and causing physiological stress (Waters 1995). Berg and Northcote (1985) observed changes in social and foraging behavior and increased gill flaring (an indicator of stress) in juvenile coho salmon at moderate turbidity (30-60 NTUs). In this study, behavior returned to normal quickly after turbidity was reduced to lower levels (0-20 NTU).

Any increase in turbidity associated with instream work is likely to be brief and occur only in the vicinity of the site, attenuating downstream as suspended sediment settles out of the water column. Temporary spikes in suspended sediment may result in behavioral avoidance of the site by fish; several studies have documented active avoidance of turbid areas by juvenile and adult salmonids (Bisson and Bilby 1982, Lloyd 1987, Servizi and Martens 1992, Sigler *et al.* 1984).

The effects of increased sedimentation and turbidity will be mitigated by the timing of construction (July 15 through September 30) and by implementing the Project's minimization measures, incorporated into the Project's SWPPP and Section 401 Water Quality Certification. As described in the Project's Conservation Measures above (Sections 1.3.4.7.1 and 1.3.4.7.2), measures include provisions to control erosion and sedimentation, as well as a Spill Prevention and Response Plan to avoid, and if necessary clean up, accidental releases of hazardous materials. As the Project's proponent, USFWS AFRP through its representatives, SYRCL, CFS, cbec and the construction contractor (SRI), would be responsible for ensuring compliance with all conditions of these measures.

With the minimization measures described above, there would be short-term, minimal adverse effects of sediment and turbidity on CV spring-run Chinook salmon and CCV steelhead and their designated critical habitat.

2.5.2. Mercury

Restoration activities have the potential to expose clay and silt sized particles with elevated mercury levels that could then be transported into the wetted channel of the LYR during high flow events. A fraction of the mercury may then methylate and become toxic to fishes and other biota. The inundation of floodplains is a potential risk factor for methylation, mobilization, and transport of mercury. Methylmercury has a range of toxic effects to fish including behavioral, neurochemical, hormonal, and reproductive changes. Berntssen *et al.* (2003) found that methylmercury caused altered behavior and pathological damage in Atlantic salmon (*Salmo salar*). Fall-run Chinook salmon that spent time rearing in the Yolo Bypass accumulated more methylmercury than salmon that remained in the Sacramento River (Henery *et al.* 2010). However, juvenile salmon rearing in the Yolo Bypass grew faster (0.7% more per day) than fish that remained in the Sacramento River (Henery *et al.* 2010), presenting a potential trade-off between the two habitats.

The Hallwood Side Channel and Floodplain Habitat Restoration Project, located 4 miles (6.4 km) downstream from the Action Area, conducted mercury sampling in fine sediment that had been recently exposed following restoration activities, similar to the effects expected to occur in the proposed Project. Slightly elevated mercury levels were observed within the construction footprint, with a maximum value of 0.42 mg/kg (USFWS, unpublished data). However, this is well below levels considered hazardous by the California Regional Water Quality Control Board (20 mg/kg; Marshack 1986).

In order to reduce the potential water quality impacts related to the release of methylmercury, mercury sampling and mitigation measures that will be included in the Section 401 Water Quality Certification. With implementation of these measures, potential impacts are expected to be minimized, such that impacts would be insignificant to salmonids and their habitat.

2.5.3. Contaminants from Spills or Leakage

During restoration activities, the potential exists for spills or leakage of toxic substances that could enter the LYR. Refueling, operation, and storage of construction equipment and materials could result in accidental spills of pollutants (*e.g*., fuels, lubricants, sealants, and oil). High concentrations of contaminants can cause (sub-lethal to lethal) effects on fish. Direct effects include mortality from exposure or increased susceptibility to disease that reduces the overall health and survival of the exposed fish. The severity of these effects depends on the contaminant, the concentration, duration of exposure, and sensitivity of the affected life stage. A potential effect of contamination is reduced prey availability; invertebrate prey survival could be reduced following exposure, decreasing food availability for fish.

Fish consuming contaminated prey may also absorb toxins directly, and be exposed to bio-magnification of the contaminant as it moves up the food chain. For salmonids, potential effects of reduced water quality during construction will be addressed by avoiding construction during times when salmonids are most likely to be present, utilization of vegetable-based lubricants and hydraulic fluids in equipment operated in the wetted channel, and by implementing the housekeeping measures incorporated into the SWPPP. These measures include provisions to control erosion and sedimentation, as well as a Spill Prevention and Response Plan to avoid, and if necessary, clean up accidental releases of hazardous materials (see Conservation Measures Sections 1.3.4.71 and 1.3.4.7.2 above). As the Project's proponent, USFWS AFRP through its representatives, SYRCL, CFS, CBEC, and the construction contractor (SRI), would be responsible for ensuring compliance with all conditions of these measures.

Potential temporary effects to salmonids related to contaminants will be addressed by the measures described in the Conservation Measures above. With implementation of these measures, potential impacts are expected to be minimized, such that impacts would be insignificant to salmonids and their habitat.

2.5.4. Noise

Noise generated by heavy equipment and personnel during construction activities could adversely affect fish and other aquatic organisms. The potential direct effects of underwater noise on fish and other organisms depend on a number of biological characteristics (*e.g*., fish size, hearing sensitivity, behavior) and the physical characteristics of the sound (*e.g*., frequency, intensity, duration) to which fish and invertebrates are exposed. Potential direct effects include behavioral effects, physiological stress, physical injury (including hearing loss), and mortality.

Exposure of adult and juvenile salmonids to noise will be minimized by conducting all instream activities during a construction season to between July 15 and September 30, when minimal numbers of adult and juvenile CV spring-run Chinook salmon and CCV steelhead will be present in the Action Area. Once construction has begun, individual fish are likely to detect the sounds and vibrations and avoid the immediate area. In addition, the shallow nature of the water within the work area, as well flowing water adding ambient sound will act to attenuate propagated sound within the water column. Therefore, fish are not expected to be exposed to sound levels that may cause physical injury. Any fish disturbed by the limited aquatic noise generated by construction activities are expected to move away to suitable habitat with lower sound levels. Therefore, the effects of increased noise will be minor and are unlikely to result in injury or death to juvenile CCV steelhead, juvenile CV spring-run Chinook salmon, or adult CV spring-run Chinook salmon that may be present. Furthermore, due to the timing of construction activities during the July 15 to September 30 period in-water work window, adult CCV steelhead are not expected to be present, and thus impacts to this life stage of this species is considered improbable, and therefore discountable.

2.5.5. Potential Effects of Instream Construction Activities on Individual Fish

Instream construction activities are expected to result in reduction in the abundance of benthic aquatic macroinvertebrates within the immediate sediment placement areas when they are covered with coarse sediment. However, not all invertebrates will be smothered and many will move up through the material to colonize the new surface layer (Merz and Chan 2005).

Effects to aquatic macroinvertebrates from coarse sediment smothering will be temporary, because construction activities will be relatively short in duration and rapid recolonization (about two weeks to two months) of the new sediment is expected (Merz and Chan 2005). Furthermore, downstream drift is expected to temporarily benefit any downstream, drift-feeding organisms, including juvenile salmonids. The benthic macroinvertebrate production within the site is expected to increase when the project is complete as there will be an overall increase in area of perennial riffle habitat, riparian areas with input from riparian vegetation, and floodplain expansion. The amount of food available for juvenile salmonids and other native fishes is, therefore, expected to increase relative to pre-project conditions.

While the in-water construction period is scheduled to take place during the dry summer period (July 15 through September 30) when the majority of salmonids are not expected to be within the Action Area, some juvenile CCV steelhead and juvenile CV spring-run Chinook salmon may nevertheless be present during instream construction activities, and thus subject to the above effects. Furthermore, juvenile salmonids are highly mobile and will rapidly move away from an area subject to disturbance. Therefore, any juvenile CV spring-run Chinook salmon and CCV steelhead that may be present in locations where in-water work is occurring without fish relocation (the construction approach) would be able to avoid construction impacts by temporarily or permanently migrating downstream, away from the Action Area. Adult CCV steelhead are not expected to be present during instream construction activities, and adult CV spring-run Chinook salmon movement at night will be undisturbed as they move within the main river channel away from the construction areas, thus impacts to this life stage of these species is considered improbable, and therefore discountable.

While the temporary displacement of fish is not expected to significantly affect the survival of individual fish or the population as a whole, it may cause reduced feeding and temporary behavior changes. Fish that are displaced will be able to access adjacent habitat, and will be able to access the site again immediately upon construction completion. CFS (2021) reported that juvenile salmonids were observed feeding immediately downstream of gravel placement activity and returning to placement sites immediately after equipment activity has ceased. In addition, the Project has incorporated additional measures into their conservation measures including a work window targeting reduced fish presence and fish relocation to avoid injury and mortality of fishes from construction activities. Fish will be relocated if necessary, away from areas where instream work occurs. Active relocation will only occur if it is not possible to maintain a path of egress for fish during construction (effects associated with relocation are discussed separately below). With the minimization measures described above, some small amount of short-term adverse effects on juvenile CV spring-run Chinook salmon and CCV steelhead cause by channel modification are expected during construction periods.

Fish Relocation

To avoid injury or mortality of fishes from construction activities, fish will be relocated, if necessary, away from areas where instream work occurs. Active relocation will only occur if it is not possible to maintain a path of egress for fish during Project construction. Fish will be relocated either through herding and excluding them out of the work area, or through capture and relocation. Data to precisely quantify the number of CCV steelhead and CV spring-run Chinook salmon that will be relocated prior to construction are not available. Relocation may affect over-summering pre-smolt juvenile steelhead, because the work will be performed during the summer low flow period after out-migrating steelhead smolts have left and before adult steelhead have immigrated to or through the Action Area.

Likewise, relocation is not likely to affect adult spring-run Chinook salmon, as the instream work areas are comprised of habitat that is not considered as holding or migration habitat for adult spring-run Chinook salmon. Fish relocation may potentially affect juvenile spring-run Chinook salmon, but the work will be performed after the majority of juvenile spring-run Chinook salmon have out-migrated from the LYR. It is possible that juvenile spring-run Chinook salmon that are demonstrating the yearling rearing strategy could be present and would therefore be affected by relocation. However, the yearling life history strategy is uncommon in LYR CV spring-run Chinook salmon (Yuba RMT 2013).

Fish relocation activities pose a risk of injury or mortality to rearing juvenile CCV steelhead and CV spring-run Chinook salmon. Any fish collecting gear, whether passive or active (Hayes 1983), has some associated risk to fish, including stress, disease transmission, injury, or death. The amount of unintentional injury and mortality attributable to fish relocation varies widely depending on the method used, ambient environmental conditions, such as water temperature, and the experience of the field crew. The effects of seining and dip-netting on juvenile salmonids include stress, scale loss, physical damage, suffocation, and desiccation. Electrofishing can kill juvenile salmonids, and researchers have found serious sublethal effects including spinal injuries (Habera *et al.* 1996; Habera *et al.* 1999; Nordwall 1999; Holliman and Reynolds 2002; Nielsen and Johnson 1983). However, fish relocation activities will be conducted by qualified fisheries biologists following both the CDFW and NMFS guidelines. Therefore, direct effects to, and mortality of, juvenile CCV steelhead and CV spring-run Chinook salmon during relocation activities are not likely to occur based on the implementation of the guidelines and the use of experienced field crews. Whenever feasible, fish relocation will be attempted using herding first, as this method is expected to have a lower impact on the species relative to active relocation methods (*e.g*., seining or electro-fishing), since fish will not be handled and will not be subject to holding and transport stress.

Fish collection or herding is unlikely to be 100 percent effective at removing all individuals in the in-water work area, but experienced biologists are expected to remove at least 95 percent of the fish present based on past actions. The actual number of juvenile CCV steelhead and CV spring-run Chinook salmon that evade capture and remain in the construction area and thus may be subsequently injured or killed from construction activities is considered to be very small. This is due to the very low numbers of fish that are expected to potentially be present during the summer in-water work window.

The anticipated capture, handling, and associated harm of CCV steelhead and CV spring-run Chinook salmon due to relocation activities is expected to be low, as no CCV steelhead or CV spring-run Chinook salmon were observed in the Project's construction footprint during pre-project surveys that took place during the months when construction would occur. However, the applicant believes that up to 100 individuals of each species may be handled during relocation efforts occurring during the Project's construction actions (

Table 15). Of these fish, NMFS anticipates that mortality rates will be typically less than 3 percent of fish handled based on previous fish relocation actions. Loss of fish during relocation will also be minimized by the implementation of the conservation measures described in section 1.3.4.7.3 under *Fish Capture and Relocation.*

2.5.6. Post-construction Restoration Effectiveness Monitoring

The long-term monitoring efforts accompanying the proposed Project aim to measure changes in hydrology, geomorphology, and river ecosystem function related to CCV steelhead and CV spring- and fall-run Chinook salmon habitat use (CFS 2021). Pre-project monitoring began under an existing 4(d) permit held by CFS and was performed in 2017, 2018, and 2020. Post-project monitoring will be performed for up to three years following construction and will be covered by this biological opinion. The specific monitoring methods and anticipated effects are described below.

Macroinvertebrate Sampling

As detailed in Section 1.3.4.6.2, changes to macroinvertebrates (juvenile salmonid prey-base) will be assessed before and after implementation using drift and Schindler sampling. Sampling efforts will require minor disturbance of benthic substrate through wading to perform the sampling. Care will be taken to avoid areas being used by adult salmonids (*e.g*., active redds). If juvenile or adult salmonids are observed during macroinvertebrate sampling, effort will be made to avoid disturbing them by not sampling or wading in their vicinity. Juvenile and adult salmonids can easily avoid staff and equipment associated with these sampling activities, and individuals that are spooked away from their holding/rearing area during invertebrate sampling will return to the area when the disturbance from sampling has ceased. Biological impacts from macroinvertebrate sampling are considered temporary and are not likely to adversely impact salmonids and are, therefore, insignificant.

Snorkel Surveys

Snorkel surveys will require survey biologists to observe and enumerate rearing juvenile salmonids within the Action Area and record the GPS coordinates, as well as depth and velocity in the locations in which juvenile salmonids are observed. Snorkel surveys will typically be performed monthly from January through October to capture the breadth of juvenile rearing, including over-summer habitat use. Adult CCV steelhead may be observed during juvenile salmonid snorkel surveys during January through April, as these months overlap with the migration, holding, and spawning of steelhead in the LYR. Adult CV spring-run Chinook salmon may be observed from April to October as these months overlap with their spawning migration, upstream holding, and spawning in the LYR (

Table 7). Actively spawning adult salmonids will be avoided during snorkel surveys by not wading or surveying in their vicinity.

The presence of individuals conducting the snorkel surveys may cause minimal temporary disturbances to fish behavior and habitat use. Observation without handling is the least disruptive method for determining a species' presence/absence and estimating their relative numbers. Its effects are also generally the shortest-lived and least harmful of the research activities because a cautious observer can effectively obtain data while only slightly disrupting the fishes' behavior. Fry and juveniles frightened by the turbulence and sound created by observers are likely to seek temporary refuge in deeper water or behind or under rocks or vegetation. In extreme cases, some individuals may leave a particular pool or habitat type and then return when observers leave the area. At times, the research involves observing adult fish, which are more sensitive to disturbance. Per the guidelines described for the Project, adult fish will be avoided if possible, limiting the level of disturbance.

Harassment is the primary form of take associated with these observation activities, and no injury or deaths are expected to occur. Because these effects are so small, there is little a researcher can do to mitigate them, except to avoid disturbing sediments, gravels, and, to the extent possible, the fish themselves, and allow any disturbed fish the time they need to reach cover. Effects in the form of harassment are expected to occur to adult and juvenile CCV steelhead and CV spring-run Chinook salmon during the extent of post-monitoring construction activities.

During pre-project snorkel surveys of selected transects, which were covered under a 4(d) permit, 1 to 131 juvenile *O. mykiss* and 0 to 16,869 juvenile Chinook salmon were observed per year during 2017, 2018, and 2020. Post-project monitoring snorkel surveys will be conducted from January to October, which is a similar timeframe to snorkel surveys conducted in 2020. Assuming the restoration project improves juvenile salmonid habitat and resulting occupancy as intended, NMFS anticipates the number of fish disturbed by the snorkeling surveys will increase. NMFS estimates post-project occupancy will increase by a factor of six over 2020 observations. Based on this assumption, juvenile *O. mykiss* post-project snorkel observations may be as high as approximately 800 juvenile fish annually. Assuming approximately one third of all juvenile Chinook salmon observed during snorkel surveys in 2020 were spring-run Chinook salmon (resulting in a total of 5,623 CV spring-run Chinook salmon), post-project observations are predicted to be approximately 34,000 fish over the 2-year study period. Following post-project sampling, the actual number of juvenile spring-run Chinook salmon observed during snorkel surveys will be estimated for reporting purposes by applying the ratio of spring-run to fall-run Chinook salmon juveniles observed in the genetic analysis of PIT-tagged fish (see below).

Beach Seine and Fyke Net Sampling

The proposed research activities will have no measurable effects on the listed salmonids' habitat. The actions are, therefore, not likely to jeopardize any of the listed salmonids by reducing the ability of that habitat to contribute to their survival and recovery. The primary effect of the proposed research will be on the listed species in the form of capturing and handling the fish. Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, let alone entire species.

Beach seine sampling will be performed to capture juvenile Chinook salmon for use in the rearing study in the spring (April/May) and to monitor juvenile salmonid habitat use within the main channel, side-channel, and floodplain in the Action Area. Up to four locations will be seined within each habitat type (main channel, side channel, and floodplain) with up to three seine hauls per location. Seine sampling will occur monthly from February through June. The seine size used will be based on the configuration of the seine location with a larger seine used in the main channel and a smaller seine used in the side channel. Seining will require wading by individuals operating the seine net and the net will agitate stream bottom substrate where it is deployed.

Fyke net sampling will be used to capture juvenile salmonids during the growth studies. The fyke net(s) will be installed in the downstream end of Project Backwater and Control Backwater sites. The fyke net will be "fished" continuously for the duration of the experiment, approximately four weeks in the spring (April/May). The fyke-nets will be checked up to twice a day to process fish in the live boxes and to clean debris from the traps and live boxes.

Chinook salmon captured by the beach seine for the pre- and post-project juvenile rearing experiment will be weighed and measured, PIT tagged, and genetic fin-clip/swab collected, and placed in a recovery bucket. Once fish in the recovery buckets are behaving normally, the fish will be returned to a proper release location within the area from which they were captured, except for the PIT-tagged fish which will be transported to the selected experimental release location. Similarly, fish captured in the fyke net sampling will also be anesthetized, scanned for a PIT-tag, weighed and measured, and then placed in a recovery bucket. All fish will be released downstream of the fyke net except for a sub-sample of 100 recaptured PIT-tagged fall-run Chinook Salmon, which will be sacrificed for otolith and diet analysis.

Harassment caused by capturing, handling, and releasing fish generally leads to stress and other sub-lethal effects that are difficult to assess in terms of their impact on individuals, populations, and species (Sharpe *et al.* 1998). Handling of fish may cause stress, injury, or death, which typically are due to overdoses of anesthetic, differences in water temperatures between the river and holding buckets, depleted dissolved oxygen in holding buckets, holding fish out of the water, and physical trauma. Stress on salmonids increases rapidly from handling if the water temperature exceeds 18ºC or dissolved oxygen is below saturation. Fish transferred to holding buckets can experience trauma if care is not taken in the transfer process, and fish can experience stress and injury from overcrowding in traps, nets, and buckets. Decreased survival of fish can result when stress levels are high because stress can be immediately debilitating and may also increase the potential for vulnerability to subsequent challenges (Sharpe *et al.* 1998).

The pre-established set of conservation measures described in Sections 1.3.4.6.3 and 1.3.4.7.3 contain measures that mitigate factors that commonly lead to stress and trauma from handling, and thus minimize the harmful effects of capturing and handling fish. When these measures are followed, fish typically recover fairly rapidly from handling. Nevertheless, mortality from seines are expected to be less than two percent of the fish captured, and less than one percent for fyke nets.

Tissue sampling techniques, such as fin-clipping, are common to many scientific research efforts using listed species. All sampling, handling, and clipping procedures have an inherent potential to stress, injure, or even kill the fish. This section discusses tissue sampling processes and its associated risks.

Fin clipping to obtain genetic samples is the process of removing a small part of one fin to obtain non-lethal tissue samples. Many studies have examined the effects of fin clips on fish growth, survival, and behavior. The results of these studies are somewhat varied; however, it can be said that fin clips do not generally alter fish growth. Studies comparing the growth of clipped and unclipped fish generally have shown no differences between them (*e.g*., Brynildson and Brynildson 1967). Moreover, wounds caused by fin clipping usually heal quickly - especially those caused by partial clips, such as for genetic samples.

Mortality among fin-clipped fish is also variable. Some immediate mortality may occur during the marking process, especially if fish have been handled extensively for other purposes (e.g., tagging). Delayed mortality depends, at least in part, on fish size; small fishes have often been found to be susceptible to it and Coble (1967) suggested that fish shorter than 90 mm are at particular risk. The degree of mortality among individual fishes also depends on which fin is clipped. Studies show that adipose- and pelvic-fin-clipped coho salmon fingerlings have a 100 percent recovery rate (Stolte 1973). Recovery rates are generally recognized as being higher for adipose- and pelvic-fin-clipped fish in comparison to those that are clipped on the pectoral, dorsal, and anal fins (Nicola and Cordone 1973). Clipping the adipose and pelvic fins probably kills fewer fish, because these fins are not as important as other fins for movement or balance (McNeil and Crossman 1979). Mortality is generally higher when the major median and pectoral fins are clipped. Mears and Hatch (1976) showed that clipping more than one fin may increase delayed mortality, but other studies have been less conclusive. For this Project, the tissue sampling protocol is to clip a very small piece of tissue from the upper caudal fin. Tissue size will be approximately one mm^2 for fish less than 65 mm and four mm^2 for fish greater than 65 mm FL. The small size of the tissue removed is believed to have minimal chances of causing injury or mortality to the sampled fish.

Techniques, such as PIT tagging, coded wire tagging, fin-clipping, and the use of radio transmitters, are common to many scientific research efforts using listed species. All sampling, handling, and tagging procedures have an inherent potential to stress, injure, or even kill the marked fish. This section discusses each of the marking processes and its associated risks.

A PIT tag is an electronic device that relays signals to a radio receiver; it allows salmonids to be identified whenever they pass a location containing such a receiver without researchers having to handle the fish again. The tag is inserted into the body cavity of the fish just in front of the pelvic girdle. The tagging procedure requires that the fish be captured and extensively handled. In general, the tagging operations will take place where there is cold water of high quality, a carefully controlled environment for administering anesthesia, sanitary conditions, quality control checking, and a carefully regulated holding environment where the fish can be allowed to recover from the operation.

PIT tags have very little effect on growth, mortality, or behavior. The few reported studies of PIT tags have shown no effect on growth or survival (Prentice *et al.*, 1987; Jenkins and Smith, 1990;

Prentice *et al.*, 1990). For example, in a study between the tailraces of Lower Granite and McNary Dams (225 km), Hockersmith *et al.* (2000) concluded that the performance of yearling Chinook salmon was not adversely affected by gastrically or surgically implanted sham radio tags or PIT tags. Additional studies have shown that growth rates among PIT-tagged Snake River juvenile fall Chinook salmon in 1992 (Rondorf and Miller, 1994) were similar to growth rates for salmon that were not tagged (Conner *et al.*, 2001). Prentice and Park (1984) also found that PIT tagging did not substantially affect survival in juvenile salmonids.

It is not expected that the implantation of PIT tags will markedly cause mortality of the study Chinook salmon required for this Project. Based on previous studies using experienced personnel, the applicant believes that the mortality rate for PIT tagging will be less than 3 percent of fish tagged. Therefore, assuming that one third of the fish captured and PIT tagged from the beach seines are actually spring-run Chinook salmon (based on previous studies), the number of spring-run Chinook salmon that will be tagged is approximately 333 fish over the 2-year study period. A more accurate number will be determined after the results of the genetic analysis is completed.

2.5.7. Beneficial Effects from Restoration Actions

By definition, a "restoration project" is one that will result in a net increase in aquatic or riparian resource functions and services. Projects are expected to have some long-term benefit to species, primarily through increased quantity or quality of the PBFs of critical habitat. Unlike the assessment of the potential adverse impacts to critical habitat, where effects are described by the construction activities, the beneficial effects are described specific to individual project elements.

Instream habitat structures and improvement projects are expected to provide escape from predators and resting cover, increase spawning habitat, improve upstream and downstream migration corridors, improve pool to riffle ratios, and add habitat complexity and diversity in the form of side channels and backwaters that enhance rearing capacities and function. Instream habitat structures, such as woody material and boulders contribute to habitat diversity and create and maintain foraging, cover, and resting habitat for both adult and juvenile anadromous fish. Placement of instream woody material on the banks of the active channel will create instantly available habitat by creating diverse cover for juvenile rearing. Reducing the elevation of channel margins and terraces will increase the frequency of floodplain inundation, reactivating lost floodplain function for the rearing of juvenile fish.

Restoration of the floodplain functionality within the Action Area will also serve as a catalyst for the re-establishment of riparian margins and habitat. Restoration of riparian habitat is expected to improve shade and cover, protecting rearing juveniles, reducing stream temperatures, and improving water quality through pollutant filtering. Beneficial effects of enhanced riparian zones also includes the input of organic carbon and other nutrients into the aquatic habitat and fosters a healthier terrestrial and aquatic invertebrate community that enhances the forage base for juvenile salmonids.

2.5.8. Project Effects to Critical Habitat

Although some aspects of the proposed action may cause short-term adverse effects to the critical habitat of listed species, as it is a restoration project, it is designed and anticipated to improve overall habitat PBFs resulting in benefits to listed species over the long-term. Furthermore, the site selected for the Project currently exhibits degraded quality, such that the future benefit to critical habitat is expected to outweigh any temporary negative impacts caused by the restoration process. The description below describes both adverse and beneficial impacts to critical habitat of listed species.

The potential, adverse effects to CV spring-run Chinook salmon and CCV steelhead critical habitat are expected to follow the same effects pathways as the effects to species, primarily caused by the degradation of water quality through physical disturbance and increased mobilization of sediments, potential escapement of mercury particles from sediments, and temporary reductions in forage base prey species from the disturbance of the benthic habitat. These effects may be caused by a number of different project construction elements, but all are expected to be short-term. These effects are expected to cause a temporary reduction in suitable juvenile rearing and migratory habitat salmonid critical habitat.

Juvenile salmonid rearing sites require cover and cool water temperatures during the summer low-flow period. Over-wintering juvenile salmonids require refugia to escape to during high flows in the winter (Jeffres *et al.* 2008, McCormick and Harrison 2011). Temporary adverse effects to rearing habitat PBFs will primarily occur as a result of disturbing the channel during restoration work and increasing sediment input during instream activities. However, these adverse effects are expected to be temporary and of short duration, lasting only as long as project construction actions are taking place or until the first fall storm or spring freshets flush out the restoration site, removing any residual fine-grained sediments. In contrast, the restoration objectives described in the proposed Project will increase the quality of rearing habitat over the long term following the completion of construction activities. Rearing habitat will be improved by adding complexity that will increase pool formation, cover structures, and velocity refugia, as well as increase the area of backwater and side channel habitat, floodplain habitat, and improve riparian community structure.

Temporarily explicit in-water work windows are designed to avoid impacts to salmonid spawning habitat during the spawning season(s) and egg incubation. The very limited potential to affect spawning habitat PBFs are expected to include temporary increases in fine sediment resulting from proposed Project activities. Spawning habitat is located where water velocities are higher, and thus where mobilized fine sediments are less likely to settle. Where limited settling does occur in spawning habitat within the Action Area, the minimally increased sediment is not expected to degrade spawning habitat due to the small amounts and short-term nature of the effects.

Migratory habitat PBFs are essential for juvenile salmonids emigration to the ocean as well as adults returning to their natal spawning grounds. Migratory habitat PBFs may be affected during the temporary disturbances of the secondary channel during project implementation. However, the Project's explicit temporal work window avoids periods of active migration for CCV steelhead, as well as spatially separates the migratory corridor for adult spring-run Chinook salmon that utilize the main channel during lower fall flows from the restoration sites along the secondary channel and backwater areas. The proposed action will also have long-term beneficial effects to migratory habitat. Activities adding complexity to migratory habitat PBFs are expected to increase the number of pools, side channels, and backwaters, providing resting areas for juvenile salmonids and adults, and improving access to restored habitat which provides increased rearing capacity and multiple migratory routes through the Action Area under variable flow levels. Potential temporary effects to salmonids related to short term reduction in PBFs will be addressed by the measures described in the Conservation Measures above. With implementation of these measures, potential effects on critical habitat for salmonids will be minimized. However, effects of construction activities are still expected to cause a temporary reduction in suitable juvenile rearing and migratory habitat salmonid critical habitat. Any temporary reduction in habitat is only expected to last for days to weeks, and an overall net increase in suitable habitat is expected one the project is constructed.

2.5.9. Summary of Expected take of juvenile CCV steelhead and CV spring-run Chinook salmon due to Post-construction Monitoring

The post-construction monitoring will result in the capture and handling of both CV spring-run Chinook and CCV steelhead. Although the post-construction monitoring will primarily target juvenile life stages, it is expected that a small number of adult fish will also experience harassment during observational studies while snorkeling. In addition to the capture and handling of juvenile fish during beach seining and fyke net trapping, a subset of fish will be tagged with PIT tags, requiring more extensive handling, including anesthesia, PIT tag injections, and fin clips for genetic determinations. This additional handling will lead to increased stress levels which may result in injury or death. The expected number of fish required each year to complete the monitoring activities is presented in Table 16. It is anticipated that approximately 1,500 Chinook salmon will be captured by the beach seine nets annually and PIT tagged. Of this number, approximately 33 percent will be CV spring-run Chinook (500 fish), with the remainder being CV fall-run Chinook salmon (1,000 fish). PIT tagging is expected to have a mortality rate of 3 percent for Chinook salmon. Beach seine mortality is expected to be one percent for Chinook salmon. Mortality associated with trapping in fyke nets is 0.75 percent.

2.6. Cumulative Effects

"Cumulative effects" are those effects of future State or private activities, not involving Federal activities, that are reasonably certain to occur within the Action Area of the Federal action subject to consultation [50 CFR 402.02 and 402.17(a)]. Future Federal actions that are unrelated to the proposed action are not considered in this section because they require separate consultation pursuant to Section 7 of the ESA.

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

Few future non-Federal actions that may affect the Action Area are expected to occur. Non-Federal actions that may affect the Action Area include changes in upstream hydropower operations, angling and State angling regulation changes, agricultural practices, private water contracts, habitat restoration or maintenance, water withdrawals and diversions, and increased population growth resulting in urbanization and development of floodplain habitats and the river corridor along California State Highway 20.

Existing upstream hydropower operations are currently undergoing licensing through the Federal Energy Regulatory Commission. Any effects to fish species listed under the ESA due to changes in the operation of these projects are expected to undergo ESA consultation. California angling regulations have moved toward restrictions on recreational sport fishing to protect listed fish species, but incidental hooking of natural Chinook salmon, hook and release mortality of steelhead, and disturbance of salmonid redds by wading anglers may continue to cause a threat within the Action Area and surrounding waters. Habitat restoration and maintenance projects within the Yuba River watershed may have short-term negative effects associated with in-stream construction activities, but these effects are considered temporary and localized with listed species and habitats expected to benefit in the long term. Prolonged periods of elevated water turbidity levels may result from agricultural practices discharging return flows to the river, and increased urbanization and/or development of riparian habitat. This subsequently could adversely affect the ability of juvenile salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause injury or mortality to juvenile CV spring run Chinook salmon and CCV steelhead in the vicinity and downstream of the project area.

High turbidity levels can cause fish mortality, reduce feeding efficiency, and decrease food availability (Berg and Northcote 1985). Upstream water withdrawals and diversions may result in depleted river flows that are necessary for migration, spawning, rearing, flushing of sediment from spawning gravels, gravel recruitment, and transport of large woody debris. Future urban and/or rural residential development may adversely affect water quality, riparian function, and aquatic productivity through alterations to the river corridor. Most of these actions would require Federal permits, and would undergo individual or programmatic Section 7 consultation. No known specific and reasonably certain future state or private activities are expected to occur within the Action Area, other than those ongoing activities already discussed in the existing conditions.

2.7. Integration and Synthesis

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

CCV steelhead, and CV spring-run Chinook salmon have experienced significant declines in abundance and the availability of suitable habitat in the California CV relative to historical conditions. Much of the historical habitat used for spawning and rearing now lies above valley floor rim dams and is inaccessible to these fish. Habitat that is currently available is a mere fraction of that which was historically available and is located in the tailwaters of impassable dams located in the lower elevation foothills of the Central Valley. The suitability of these waters for spawning, egg incubation, and rearing of fry and juveniles is highly dependent on the cold-water pools contained in these dams, which is itself vulnerable to climate change and increasing human demands.

The status of the species and critical habitat and Environmental Baseline sections (2.2 and 2.4) detail the current range-wide status of the CV spring-run Chinook salmon ESU and the CCV steelhead DPS, the status of their designated critical habitat, and the current baseline conditions found in the LYR, where the proposed project is to occur. Sections 2.2.1 and 2.4.5 discuss the vulnerability of listed species and critical habitat to climate change projections in California's Central Valley and specifically in the LYR. In light of the predicted impacts of global warming, it has been hypothesized that summer temperatures and flow levels will become unsuitable for salmonid survival in many parts of California. However, because of specific physical and hydrologic factors (discussed in Section 2.4.5), the LYR is expected to continue to provide the suitable cold-water temperature conditions for anadromous salmonids, even if there is warming related to long-term climate change.

Cumulative effects that may affect the Action Area include hydropower operations, angling and State angling regulation changes, agricultural practices, private water contracts, habitat restoration or maintenance, water withdrawals and diversions, adjacent mining activities, and increased population growth resulting in urbanization and development of floodplain habitats. The proposed Project contains restoration actions that are consistent with the NMFS recovery plan (NMFS 2014) for CV spring-run Chinook salmon and CCV steelhead, and are intended to aid in their long-term recovery and survival. The Recovery Plan in particular calls out for the development of programs and implementation of projects on the LYR that promote natural riverine processes, including projects that add riparian habitat and instream cover (Action identification YUR 1.3). This Project addresses those elements. Likewise, the Project also addresses YUR 2.1 (large woody material restoration), YUR 2.2 (increases in floodplain habitat availability), YUR 2.4 (creation and restoration of side channels), among others.

2.7.1. Effects of the Proposed Project to Listed Species

While the in-water construction period is scheduled to take place during the dry summer period (July 15-September 30) when the majority of juvenile salmonids is not expected to be within the Action Area, some juvenile CCV steelhead and juvenile CV spring-run Chinook salmon may nevertheless be present during instream construction activities, and thus subject to project-related effects.

Juveniles may be harassed, captured, injured, or killed during construction, monitoring, and post-construction monitoring activities. Adult CCV steelhead, adult CV spring-run Chinook salmon, and juvenile CV spring-run Chinook salmon may be harassed by post-construction monitoring activities. Construction of side channel habitat and floodplain modification are likely to result in sediment and turbidity pulse events which may result in small temporary effects to juvenile salmonids due to increased activity, avoidance behaviors, and reduced foraging capability. Best management practices, minimization and avoidance measures implemented during implementation of the proposed project will minimize direct impacts to ESA-listed fish in the LYR.

2.7.1.1 CV Spring-run Chinook salmon

The proposed project has the potential to affect various life stages CV spring-run Chinook salmon. However, the only life stages that are expected to be present in the Action Area during construction are juvenile and adult CV spring-run Chinook salmon. Adult CV spring-run Chinook salmon movement at night will be undisturbed as they move within the main river channel away from the construction areas, though they may be present during post-construction monitoring. Monitoring effects to adults are likely going to be limited to harassment, and no injury or lethal effects are expected. Juveniles may be captured, injured, or killed during construction and monitoring. Construction of side channel habitat and floodplain modification are likely to result in sediment and turbidity pulse events which may result in adverse effects to juvenile salmonids due to increased activity, gill fouling and reduced foraging capability. Best management practices, minimization and avoidance measures implemented during implementation of the proposed project will minimize direct impacts to ESA-listed fish in the LYR.

NMFS listed the CV spring-run Chinook salmon ESU as a threatened species in 1999 and reaffirmed the species' status in 2005 and 2016. Major concerns for this ESU are low numbers, poor spatial structure, and low diversity. At this time, demographically independent populations persist only in the northern Sierra Nevada diversity group (Mill, Deer, and Butte creeks, which are tributaries to the upper Sacramento River) (NMFS 2014). While the Yuba River is included within the Northern Sierra Nevada Diversity group, it is not considered an independent population as of now. Increased rearing habitats can directly benefit this population by reducing known stressors, which may lead to increased viability of the population.

The recovery plan (NMFS 2014) listed a number of threats to the recovery of the Central Valley spring-run Chinook salmon ESU. Some of these threats include, but are not limited to operation of antiquated fish screens, fish ladders, and diversion dams; inadequate flows; and levee construction and maintenance projects that have greatly simplified riverine habitat and disconnected rivers from the floodplain (NMFS 2016a). While the effects of the proposed action on individuals from this ESU include the temporary reduction in quality of rearing habitat in the LYR, the end result of the project will increase access to higher quality rearing habitat to fish within the LYR. The newly created habitat is expected to have more foraging habitat, refugia from predators, and increased shading and aquatic vegetation.

The expected maximum take of CV spring-run as a result of the proposed action can be seen below in Tables 15 (construction-related take) and 16 (monitoring take). Overall, the take does not reflect a significant portion of the ESU. Take in the form of harassment by snorkel surveys is the highest expected value, but as described in the Effects section above, studies have shown that snorkel surveys have very minimal effects to fish, and normal behaviors are expected to resume within minutes after encounters. Lethal take is expected to occur, but the summation of all lethal take will not exceed 0.001% of the ESU, a total of 38 individual juvenile fish. Overall, this is a negligible impact to the LYR population, and ESU overall.

Table 15. Expected take of juvenile CCV steelhead and CV spring-run Chinook salmon due to fish relocation activities during Proposed Project construction.

Species	Method	Take Action	Life Stage	Expected Take	Expected Lethal Take
CCV steelhead	Fish Relocation	Capture/Handle/Release Fish	Juvenile	100	3
CV spring-run Chinook salmon	Fish Relocation	Capture/Handle/Release Fish	Juvenile	100	3

Table 16. Expected number of study fish required annually to complete post-construction monitoring. Juvenile fish are assumed to be comprised of naturally spawned fish only. Adult fish may be either wild or hatchery.

Species	Method	Take Action	Life Stage	Expected Annual Take	Annual Lethal Take	Percent of ESU/DPS taken	Percent of ESU/DPS killed
CV spring-run Chinook Salmon	Beach Seine	Capture/ Handle/PIT-tag/Genetic Sample/ Release Fish	Juvenile	500	15	0.02	0.0007
CV spring-run Chinook Salmon	Beach Seine	Capture/ Handle/ Release Fish	Juvenile	500	5	0.02	0.0002
CV spring-run Chinook Salmon	Fyke Net	Capture/ Handle/ Release Fish	Juvenile	2,000	15	0.10	0.0007
CV spring-run Chinook Salmon	Snorkel Surveys	Observe/ Harass	Juvenile	17,000	0	0.8	0.000
CV spring-run Chinook Salmon	Snorkel Surveys	Observe/ Harass	Adult	10	0	0.1	0.00
CCV steelhead	Beach Seine	Capture/ Handle/ Release Fish	Juvenile	300	1	0.02	<0.00001
CCV steelhead	Fyke Net	Capture/ Handle/ Release Fish	Juvenile	200	1	0.02	<0.00001
CCV steelhead	Snorkel Surveys	Observe/ Harass	Juvenile	1,000	0	0.09	0.00
CCV steelhead	Snorkel Surveys	Observe/ Harass	Adult	20	0	0.09	0.00

As described above, the risk to the CV spring-run Chinook salmon posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. Reductions in the population can be highly detrimental to the ESU. The Action Area is the migratory and rearing corridor that is used by both adults and juveniles. The proposed action will increase access to historical floodplain habitat, thereby reducing a known stressor to the population. While the action is expected to result in take of fish initially, the benefits of the project in the long-term will reduce known stressors on fish, and is expected to increase overall juvenile survival within the LYR.

2.7.1.2 CCV Steelhead

The proposed project has the potential to affect various life stages of CCV steelhead. However, the only life stage that is expected to be present in the Action Area during construction is juvenile CCV steelhead. Juveniles may be captured, injured, or killed during construction and monitoring. Construction of side channel habitat and floodplain modification are likely to result in sediment and turbidity pulse events which may result in adverse effects to juvenile salmonids due to increased activity, gill fouling and reduced foraging capability. Best management practices, minimization and avoidance measures implemented during implementation of the proposed project will minimize direct impacts to ESA-listed fish in the LYR.

NMFS listed the CCV steelhead DPS as a threatened species in 1998 and reaffirmed the species' status in 2005 and 2016. Before dam construction, water development, and other watershed perturbations, steelhead were found from the upper Sacramento and Pit rivers (now inaccessible 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 (NMFS 2014). There may have been at least 81 independent populations, distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin rivers. Currently, steelhead spawn in the Sacramento, Feather, Yuba, American, Mokelumne, Stanislaus, and Tuolumne rivers and tributaries, including Cottonwood, Antelope, Deer, Clear, Mill, and Battle creeks. Spawning likely occurs in other streams, but the lack of a comprehensive Central Valley steelhead monitoring program makes the amount and extent of spawning difficult to know. Major concerns across the range include passage impediments and barriers, warm water temperatures for rearing, hatchery effects, limited quantity and quality of rearing habitat, predation, and entrainment.

Many watersheds in the Central Valley are experiencing decreased abundance of steelhead (NMFS 2016b). Dam removal and habitat restoration efforts in Clear Creek appear to be benefiting the DPS as observers have reported unclipped (naturally produced) steelhead in recent years. However, adult numbers are still low, a large percentage of the historical spawning and rearing habitat is lost or degraded, and smolt production is dominated by hatchery fish. Many planned restoration and reintroduction efforts have yet to be implemented or completed. Most natural origin steelhead populations 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 and drought (NMFS 2016b). Currently the CCV steelhead DPS is at moderate risk of extinction (NMFS 2016c). However, there is considerable uncertainty with regard to the magnitude of that risk, due in large part to the general lack of information and uncertainty regarding the status of many of its populations. Here, the combined risk to individual populations are evaluated to determine the risk to the DPS as a whole.

The expected maximum take of CCV steelhead as a result of the proposed action can be seen above in Tables 15 (construction-related take) and 16 (monitoring take). Overall, the take does not reflect a significant portion of the DPS. Take in the form of harassment by snorkel surveys is the highest expected value, but as described in the Effects section above, snorkel surveys have very minimal effects to fish, and normal behaviors are expected to resume within minutes after encounters. Lethal take is expected to occur, but the summation of all lethal take will not exceed 0.0001% of the ESU, a total of 5 individual juvenile fish for the entirety of the action. Overall, this is a negligible impact to the overall LYR population, and ESU as a whole.

As described above, the risk to steelhead posed by the proposed action is evaluated in the aggregate context of the species' status, the environmental baseline, cumulative effects, and effects from other activities that would not occur but for the Proposed Action and also reasonably certain to occur. Because the DPS is composed of several populations within four diversity groups, the effects of and risks associated with the proposed action must be considered in the context of the distribution of populations across multiple diversity groups. As the Proposed Action is affecting a migratory corridor of a single population within the Northern Sierra Nevada Diversity group, the overall effects to the DPS are smaller. The Action Area is a migratory corridor that is used by both adults and juveniles. The proposed action will result in increased access to historical floodplain habitat, thereby reducing a known stressor to the population. While the action is expected to result in take of fish initially, the benefits of the project in the long-term will reduce known stressors on fish, and is expected to increase overall juvenile survival within the LYR.

2.7.2. Effects of the Proposed Project to Designated Critical Habitat

The proposed action area (the Yuba River) is within the designated critical habitat for CV spring-run Chinook salmon and CCV steelhead. The Physical and Biological Features (PBFs) for CV spring-run Chinook salmon and CCV steelhead critical habitat include (1) freshwater spawning sites, (2) freshwater migratory corridors, (3) freshwater rearing sites, and (4) estuarine habitat. There have been many efforts to repair or restore the degraded condition of the physical and biological features of critical habitat for these species over the years. These actions have improved the freshwater spawning sites through water temperature management and spawning gravel augmentation, the migratory corridor through dam removal and fish passage improvements using fish ladders and through selective barrier installations, freshwater rearing sites through habitat restoration projects and fish screen installation on water diversions; and estuarine habitat through habitat restoration.

Critical habitat for both species is highly degraded due to the effects of past and ongoing actions. Ongoing private, state, and federal actions and future non-federal actions are likely to continue to impair the function of physical and biological features and slow or limit development of these features, although restoration actions will counteract these effects to some degree. Climate change is expected to further degrade the suitability of habitats in the Central Valley through increased temperatures, increased frequency of drought, increased frequency of flood flows, overall drier conditions, and altered estuarine habitats.

While the proposed action is likely to affect a small portion of the LYR migration and rearing habitat within designated critical habitat for CV spring-run Chinook and CCV steelhead temporarily, the proposed action is expected to have an overall increase in the PBFs for freshwater migratory corridors and freshwater rearing sites. NMFS expects the proposed implementation of the Proposed Action will result in temporary diminished function of these PBFs during the construction activities. However, the proposed conservation measures and restoration actions are expected to improve habitat function within the action area such that, on the whole, the function of physical and biological features of critical habitat will not be appreciably reduced.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the Action Area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CV spring-run Chinook salmon and CCV steelhead or destroy or adversely modify their designated critical habitat.

2.9. Incidental Take Statement

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

2.9.1. Amount or Extent of Take

While a small number of individual fish may be present in the construction area at the time of construction, NMFS cannot, using the best available information, precisely quantify and track the amount or number of individuals that are expected to be incidentally taken (injure, harm, kill, etc.) per species as a result of all aspects of the construction activities associated with the proposed action. This is due to the variability and uncertainty associated with the response of listed species to the effects of the proposed action, the varying population size of each species, annual variations in the timing of spawning and migration, individual habitat use within the Action Area, and difficulty in observing injured or dead fish. However, it is possible to estimate the extent of incidental take by designating as ecological surrogates, those elements of the project that are expected to result in incidental take, that are more predictable and/or measurable, with the ability to monitor those surrogates to determine the extent of take that is occurring.

The most appropriate threshold for incidental take is an ecological surrogate of habitat disturbance, which includes the loss of habitat through the disturbance of the channel. This degradation is expected to result in temporary reduction in the feeding, growth, and reduction of the quality of the existing habitat.

Incidental take, in the form of harm resulting in behavioral modifications or fish responses to habitat disturbance are described as follows. Temporary behavioral modifications resulting from the degradation of existing habitat and disturbance from construction activities is expected to occur. Observation and accurate quantification of the number of individual fish within the river channel is not possible due to water clarity during construction. However, all fish passing through or otherwise present in the Action Area during construction activities will be exposed. Thus, the footprint of the site defines the area in which projected incidental take will occur for the construction portion of this project, due to the effects of construction actions and the habitat disturbance associated with it. NMFS anticipates incidental take will be limited to the following:

1. Harm to juvenile spring-run Chinook salmon and steelhead from increased turbidity in the footprint of the proposed project from construction activities, extending upstream and downstream 1,000 feet from the footprint of the site. This disturbed habitat will affect the behavior of fish, including displacement, which is reasonably certain to result in decreased feeding, and habitat avoidance. NMFS does not expect any mortality or morbidity of these fish due to exposure to construction related turbidity. Quantification of the number of fish exposed to turbidity is not currently possible with available monitoring data. Observations of individual fish within the river channel may be limited due to water clarity and depth. However, all fish passing through or otherwise present during construction activities at the site may be exposed to construction related turbidity events. Thus, the waterside footprint of the site plus the additional area of river channel where turbidity effects are expected to be observed defines the area in which projected take will occur for this project due to the effects of construction related turbidity. Allowable take will be exceeded if turbidity measured 1,000 feet downstream of the extent of the site exceeds double the upstream of site turbidity measurement.

2. Harm to juvenile spring-run Chinook salmon and steelhead will occur from the temporary disturbance and channel modification of 62.4 acres of habitat. This loss will affect juveniles through displacement, and loss of food, resulting in decreased fitness, growth, and survival. Allowable take will be exceeded if channel modification exceeds 62.4 acres.

Fish relocation and post-construction monitoring activities will involve direct handling and/or observations of fish, allowing for the quantification of take. Methods and gear used during relocation activities result in some associated risk to fish, including injury or death. Some fish may be killed or injured during relocation and post-construction monitoring activities. Allowable take of each species can be seen below in Table 17.

- Take in the form of harassment, capture, handling, injury, or death may occur during fish relocation activities and post-construction monitoring. Expected annual numbers of take (both lethal and non-lethal) by species and life stage are in Table 17 below. If the numbers captured or the numbers killed exceeds these amounts, incidental take will have been exceeded, triggering reinitiation.

Table 17. Expected take for all construction and monitoring related activities. Juvenile fish are assumed to be comprised of naturally spawned fish only. Adult fish may be either wild or hatchery. For Fish Relocation, take is only authorized to occur during construction activities, all other activities, take numbers are on an annual basis.

Species	Method	Take Action	Life Stage	Expected Take	Lethal Take
CCV steelhead	Fish Relocation	Capture/Handle/Release Fish	Juvenile	100	3
CV spring-run Chinook salmon	Fish Relocation	Capture/Handle/Release Fish	Juvenile	100	3
CV spring-run Chinook Salmon	Beach Seine	Capture/ Handle/PIT-tag/Genetic Sample/ Release Fish	Juvenile	500	15
CV spring-run Chinook Salmon	Beach Seine	Capture/ Handle/ Release Fish	Juvenile	500	5
CV spring-run Chinook Salmon	Fyke Net	Capture/ Handle/ Release Fish	Juvenile	2,000	15
CV spring-run Chinook Salmon	Snorkel Surveys	Observe/ Harass	Juvenile	17,000	0
CV spring-run Chinook Salmon	Snorkel Surveys	Observe/ Harass	Adult	10	0
CCV steelhead	Beach Seine	Capture/ Handle/ Release Fish	Juvenile	300	1
CCV steelhead	Fyke Net	Capture/ Handle/ Release Fish	Juvenile	200	1
CCV steelhead	Snorkel Surveys	Observe/ Harass	Juvenile	1,000	0
CCV steelhead	Snorkel Surveys	Observe/ Harass	Adult	20	0

2.9.2. Effect of the Take

In the biological 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 the species or destruction or adverse modification of critical habitat.

2.9.3. Reasonable and Prudent Measures

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

1. Measures shall be taken to minimize take associated with project monitoring.
2. USFWS AFRP shall prepare and provide NMFS with a yearly report detailing the exposure and take of listed fish species associated with the project.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of Section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USFWS AFRP 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.

The incidental take exemption conferred by this incidental take statement is based upon the proposed action occurring as described in this Biological Opinion, and in more detail in the Action Agency's Biological Assessment, as well as the Terms and Conditions noted herein. Any applicant has a continuing duty to monitor the impacts of incidental take and must report the progress of the action and its impact on the species as specified in this ITS (50 CFR 402.14). If the entity to whom a term and condition is directed does not comply with the following terms and conditions, protective coverage for the proposed action would likely lapse.

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

    a. The Corps shall provide a copy of the BA and this BO, or similar documentation, to the prime contractor, making the prime contractor responsible for implementing all applicable requirements and obligations included in these documents and to educate and inform all other contractors involved in the project as to the requirement of this BO. A notification that contractors have been supplied with this information will be provided to the reporting address below.

    b. A NMFS-approved Worker Environmental Awareness Training Program for construction personnel shall be conducted by the NMFS-approved biologist for all construction workers prior to the commencement of construction activities. The program shall provide workers with information on their responsibilities with regard to federally listed fish, their critical habitat, an overview of the life history of all the species, information on take prohibitions, protections afforded these animals under the ESA, and an explanation of the relevant terms and conditions of this BO. Written documentation of the training must be submitted to NMFS within 30 days of the completion of training.

c. USFWS AFRP and CFS must handle listed fish with extreme care and keep them in cold water to the maximum extent possible during sampling and processing procedures. When fish are transferred or held, a healthy environment must be provided (e.g., the holding units must contain adequate amounts of well-circulated water). When using gear that captures a mix of species, the permit holder must process listed fish first to minimize handling stress.

d. Handling of listed juvenile fish must cease (i.e., no sedation, measurements, weighing procedures, etc.) if the water temperature exceeds 70°F at the capture site. Under these conditions, listed fish may only be visually identified and counted. In addition, electrofishing is not permitted if water temperature exceeds 64°F.

e. If listed fish are anesthetized to avoid injuring or killing them during handling, the fish must be allowed to recover before being released. Fish that are only counted must remain in water and not be anesthetized.

f. When using anesthesia, extreme care shall be taken to use the minimum amount of substance necessary to immobilize ESA-listed salmonids for handling and sampling procedures. It is the responsibility of the researcher to determine when anesthesia is necessary to reduce injuries to ESA-listed salmonids during handling and sampling activities.

g. In the event that debris (rocks, logs, abundant vegetation, etc.) are trapped within the beach seine, researchers will remove debris before fish are centralized in the net to prevent harm. Researchers will select the smallest mesh-size seine-net or dip-net that is appropriate to achieve sampling objectives while reducing the probability that smaller fish will become gilled in the net.

h. A sterilized needle must be used for each individual injection when PIT-tags are inserted into listed fish.

i. If the any listed adult fish are unintentionally captured while sampling for juveniles, the adult fish must be released without further handling and such take must be reported to NMFS within 24 hours of occurring.

j. USFWS AFRP and CFS must exercise care during spawning ground surveys to avoid disturbing listed adult salmonids when they are spawning. Researchers must avoid walking in salmon streams whenever possible, especially where listed salmonids are likely to spawn. Visual observation must be used instead of intrusive sampling methods, especially when the only activity is determining fish presence.

k. If backpack electrofishing equipment is used during monitoring, compliance with NMFS' Backpack Electrofishing Guidelines (NMFS 2000) is required (see Attachment 1).

l. USFWS AFRP and CFS must notify NMFS as soon as possible, but no later than two days after any authorized level of take is exceeded or if such an event is anticipated to occur. The permit holder must submit a written report detailing why the authorized take level was exceeded or is likely to be exceeded.

m. USFWS AFRP and CFS are responsible for any biological samples collected from listed species as long as they are used for research purposes. USFWS AFRP and CFS may not transfer biological samples to another entity without prior written approval from NMFS.

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

   a. The USFWS AFRP shall submit to NMFS an annual report describing the exposure of ESA-listed anadromous fish species and incidental take resulting from the proposed project. This report shall be filed not later than January 31, covering the instream construction window from the previous year. An annual report regarding the monitoring shall also be submitted to NMFS by March 1, covering the fish monitoring activities for the previous calendar year. These reports should be submitted to the following address:

      Assistant Regional Administrator
      National Marine Fisheries Service
      California Central Valley Office
      650 Capitol Mall, Suite 5-100
      Sacramento California 95814-4607
      By email (preferably): ccvo.consultationrequests@noaa.gov

2.10. Conservation Recommendations

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

2.11. Reinitiation of Consultation

This concludes formal consultation for the Long Bar Salmonid Habitat Restoration Project.

Under 50 CFR 402.16(a): "Reinitiation of consultation is required and shall be requested by the Federal agency or by the Service where discretionary Federal agency involvement or control over the action has been retained or is authorized by law and: (1) If the amount or extent of taking specified in the incidental take statement is exceeded; (2) If new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not previously considered; (3) If the identified action is subsequently modified in a manner that causes an effect to the listed species or critical habitat that was not considered in the biological opinion or written concurrence; or (4) If a new species is listed or critical habitat designated that may be affected by the identified action."

3. Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity," and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include 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) of the MSA also requires NMFS to recommend measures that can be taken by the action agency to conserve EFH. Such recommendations may include measures to avoid, minimize, mitigate, or otherwise offset the adverse effects of the action on EFH [CFR 600.905(b)].

This analysis is based, in part, on the EFH assessment provided by the USFWS AFRP and descriptions of EFH for Pacific Coast Salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC 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 project. EFH is designated under the FMP within the Action Area for all runs of Chinook salmon. Specific habitats identified in PFMC (2014) for Pacific coast salmon include Habitat Areas of Particular Concern (HAPCs), identified as: 1) complex channels and floodplain habitats; 2) thermal refugia; and 3) spawning habitat. HAPCs for salmon also include all waters and substrates and associated biological communities falling within the habitat areas defined above.

3.2. Adverse Effects on Essential Fish Habitat

NMFS has evaluated the proposed project for potential adverse effects to EFH pursuant to Section 305(b)(2) of the MSA. As described and analyzed in the accompanying opinion, NMFS anticipates some short-term sediment impacts will occur downstream of the project location. The duration and magnitude of direct effects to EFH associated with implementation of the restoration project will be significantly minimized due to the multiple minimization measures utilized during project execution. Short-term adverse effects that occur will be offset by long-term beneficial effects to the function and value of EFH.

3.3. Essential Fish Habitat Conservation Recommendations

Section 305(b)(4)(A) of the MSA authorizes NMFS to provide EFH Conservation Recommendations that will minimize adverse effects of an activity on EFH. Although short-term potential adverse effects anticipated as a result of project activities, the proposed minimization and avoidance measures, and terms and conditions in the accompanying opinion are sufficient to avoid, minimize and/or mitigate for the anticipated affects. Therefore, no EFH additional Conservation Recommendations are necessary at this time to avoid, minimize, mitigate, or otherwise offset the adverse effects to EFH.

3.4. Supplemental Consultation

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

4. 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. The intended users of this opinion are USFWS AFRP and USACE. Other interested users could include SYRCL and CFS. Individual copies of this opinion were provided to the USFWS AFRP. The document will be available within 2 weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). The format and naming adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

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6. ATTACHMENTS

Attachment 1. NMFS' Backpack Electrofishing Guidelines