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

Refer to NMFS No: WCRO-2021-00894

June 10, 2021

Matthew J. Roberts
Senior Project Manager
CA North Section
U.S. Army Corps of Engineers
1325 J Street
Sacramento, CA 95814-2922

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the Yuba City Boat Ramp Sediment Removal Project (SPK-2020-00900).

Dear Mr. Roberts:

Thank you for your letter dated February 26, 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 Yuba City Boat Ramp Sediment Removal Project (SPK-2020-00900). 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 (EFH) provisions in Section 305(b) of the Magnuson-Stevens Fishery Conservation and Management Act (16 U.S.C. 1855(b)) for this action.

This biological opinion is based on information provided by the U.S. Army Corps of Engineers (Corps) and the Sutter-Butte Flood Control Agency (SBFCA), including the biological assessment (BA) developed by ECORP Consulting, Inc., for the proposed project, information supplemental to the BA provided subsequently through email correspondence, and a literature review completed by NMFS staff. A complete administrative record of this consultation is on file at the NMFS California Central Valley Office.

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

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

Please contact Amanda Cranford at Amanda.Cranford@noaa.gov or (916) 930-3706 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: ARN 151422-WCR2021-SA00077

Hillary Kraft, U.S. Army Corps of Engineers, Hillary.H.Kraft@usace.army.mil
Emily Mecke, ECORP Consulting Inc., emecke@ecorpconsulting.com
Michael Bessette, Sutter Butte Flood Control Agency, m.bessette@sutterbutteflood.org

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

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

Yuba City Boat Ramp Sediment Removal Project (SPK-2020-00900)
NMFS Consultation Number: WCRO-2021-00894

Action Agency: U.S. 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?
Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*)	Threatened	Yes	No	Yes	No
California Central Valley steelhead (*O. mykiss*)	Threatened	Yes	No	Yes	No
Southern Distinct Population Segment of North American green sturgeon (*Acipenser medirostris*)	Threatened	Yes	No	Yes	No

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

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

Issued By: A. Catherine Marcinkevage

Cathy Marcinkevage
Assistant Regional Administrator for California Central Valley Office

Date: June 10, 2021

TABLE OF CONTENTS

1. Introduction

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

1.1. Background

The National Marine Fisheries Service (NMFS) prepared the biological opinion (opinion) and incidental take statement (ITS) portions of this document in accordance with section 7(b) of the Endangered Species Act (ESA) of 1973 (16 USC 1531 *et seq*.), and implementing regulations at 50 CFR 402, as amended.

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

We completed pre-dissemination review of this document using standards for utility, integrity, and objectivity in compliance with applicable guidelines issued under the Data Quality Act (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 two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. A complete record of this consultation is on file at the NMFS California Central Valley Office.

1.2. Consultation History

On April 8, 2021, NMFS received a letter, and enclosed biological assessment (BA), dated February 26, 2021, from the U.S. Army Corps of Engineers (Corps) requesting the initiation of consultation pursuant to section 7 of the ESA, in support of the issuance of a Department of the Army permit to the Sutter Butte Flood Control Agency (SBFCA) for the Yuba City Boat Ramp Sediment Removal Project.

On April 19, 2021, NMFS requested clarification regarding the intended determinations and request for consultation. The conclusions regarding effects to ESA-listed species within the enclosed BA did not match the conclusions outlined by the Corps in their letter requesting consultation. NMFS also requested additional information regarding nighttime construction and any avoidance and minimization measures associated with dredging activities.

On April 26, 2021, the Corps clarified that they disagreed with the suggested determinations in the enclosed BA developed by ECORP Consulting, Inc. based on ESA-listed species presence in the Action Area during the proposed project. As such, the Corps verified that the final determinations included with their request for consultation are the correct ones to consider for this consultation. The Corps also provided the additional information requested by NMFS. Upon receipt of the requested information, NMFS initiated formal consultation.

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 (50 CFR 402.02). Under 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 or not the proposed action would cause any other activities and determined that it would not.

The Corps proposes to issue a Department of the Army permit to the SBFCA. The SBFCA is proposing to conduct the Yuba City Boat Ramp Sediment Removal Project (Project) at the confluence of the Feather and Yuba rivers in the cities of Yuba City and Marysville, California in Sutter and Yuba counties, respectively. The purpose of the Project is to remove sediment that has accumulated at the Yuba City Boat Ramp and the confluence of the Yuba and Feather rivers, exacerbated by the Oroville Dam Spillway incident of 2017. This has hampered recreational users and public safety as it has affected emergency vessel launching capabilities at the boat ramp. The Project has received funding from the California Natural Resource Agency through Proposition 68 to remove sediment for safety and to restore recreation access to the Feather River as part of restoration, protection, and development of river parkways in accordance with the California River Parkways Grant Program. Restoring river access and fish passage conditions at the Project will also have regional economic benefits, as guided and private fishing (heavily curtailed by river and launch conditions) bring commerce to local restaurants, hotels, and other businesses.

The proposed action consists of maintenance dredging of the confluence of the Yuba River and Feather River, including the Yuba City Boat Ramp (Figure 2). Approximately 315,600 cubic yards (CY) of dredged material would be removed within an approximately 28-acre area and may occur over two phases. Phase 1 includes the removal of approximately 65,600 CY of dredged material within an approximate 14.41-acre Dredging Area as part of restoration, protection, and development of river parkways in accordance with the California River Parkways Grant Program. Phase 2 includes an additional approximately 250,000 CY within an approximate 14.40-acre Future Dredging Area immediately downstream to further restore fish passage and improve conveyance at the confluence of the Yuba and Feather rivers to be funded by other sources. The timing of Phase 2 will depend on availability of funding and may occur concurrently with Phase 1.

1.3.1. Dredging Operations

Two potential dredging methods are being evaluated for the Project: hydraulic dredging and mechanical dredging. Either method may be used, depending upon the results of the hydrographic and geophysical surveys of the area proposed to be dredged. Hydraulic dredging involves a barge with suction to remove sediment from the river bottom and pumping the material to shore. Mechanical dredging involves a barge with equipment to excavate the sediment from the river bottom, storage of the dredged material on a transport barge, and subsequent transfer of the material from the transport barge to shore.

It is assumed that use of each method at some point during dredging operations may be necessary. Each method that would be employed is described in more detail below.

1.3.1.1. Hydraulic Dredging Methods

Hydraulic dredging would be performed, likely using a hydraulic pipeline cutterhead dredge (or cutterhead dredge), the most commonly used, versatile, and efficient dredging vessel (USACE 2015). A cutterhead dredge is equipped with a rotating cutter apparatus surrounding the intake end of a suction pipe, where it can efficiently dig and pump all types of alluvial materials and compacted deposits (USACE 2015). This dredge also has the capability of pumping dredged material long distances to upland placement areas as a slurry (USACE 2015). Slurries of 10- to 20-percent solids (by dry weight) are typical, depending upon the material being dredged, dredging depth, horsepower of dredge pumps, and pumping distance to the placement area (USACE 2015). If no other data are available, a pipeline discharge concentration of 13 percent by dry weight should be used for preliminary design purposes (USACE 2015). Pipeline discharge velocity, under routine working conditions, ranges from 15 to 20 feet per second (USACE 2015).

The cutterhead dredge is generally equipped with two stern spuds (*i.e.*, long stakes) used to hold the dredge in working position and to advance the dredge into the cut or excavating area (USACE 2015). During operation, the cutterhead dredge swings from side to side, alternately using the port and starboard spuds as a pivot (USACE 2015). Cables attached to swing anchors on each side of the dredge control lateral movement (USACE 2015). Swing anchors are set out and repositioned by anchor-handling derrick barges or, in areas where water depth precludes derrick barge passage, anchor booms (fastened to the dredge hull) have been used to set the anchors (USACE 2015). For this Project, use of anchor booms is likely.

Dredged material is either transported directly to shore via a discharge pipeline (*e.g.*, a floating or submerged discharge pipeline), or transported to and from a transportation barge if necessary. Conventional cutterhead dredges are not self-propelled and require mobilization, using towboats in order to move between dredging locations (USACE 2015); however, others are self-propelled. Typical equipment for hydraulic dredging includes cutterhead dredge vessel, transportation barge, derrick barge, and towboats. Use of a submerged high-density polyethylene (HDPE) discharge pipeline may also be required.

1.3.1.2. Mechanical Dredging Methods

Mechanical dredging methods may be used if determined to be necessary. There are primarily two types of mechanical bucket dredges: the clamshell (or grab) bucket dredge, commonly called a bucket dredge, and the backhoe dredge (USACE 2015). The bucket dredge is so named because it uses a bucket to excavate the material to be dredged (USACE 2015). Different types of buckets can fulfill various types of dredging requirements. The buckets used include the clamshell, orange-peel, and dragline types and can usually be changed quickly to suit the operational requirements (USACE 2015). The vessel can be positioned and moved within a limited area using anchors and/or spuds. When the spuds are up, the bucket itself can be used to reposition the dredge by "grabbing" the bottom in the direction of desired translation and pulling the dredge that way by taking in wire rope (USACE 2015). The barge is normally equipped with two spuds facing forward in the front of the barge and one spud at the aft end of the barge (USACE 2015). The latter is a kicking spud for advancing the dredge. Alternatively, the barge can be held in place by anchors, which are attached to winches on the dredge hull and can be placed by an attendant towboat or by a crane boom (USACE 2015).

Excavated dredged material is then placed on a transportation barge or hopper dredge (vessel with a sediment container or "hopper") that is then towed to the placement area. Material may be unloaded using a gravity dump method or by hydraulic unloader usually consisting of a barge-mounted submersible pump that pumps the dredged material via a discharge pipe to shore (USACE 2015). This operation may involve adding additional water to the dredged material in the barge to allow it to be entrained and pumped through the pipeline (USACE 2015).

Mechanical dredges are also not typically self-propelled and require the use of towboats. Typical equipment for mechanical dredging includes bucket dredge vessel, transportation barge, and towboats. Use of a submerged HDPE discharge pipeline may also be required for mechanical dredging operations.

1.3.1.3. Pre-Dredging Surveys

A Hydrographic Survey and Geophysical Survey will be performed prior to dredging to determine the presence of debris and/or larger boulders/rocks that may require the use of mechanical dredging in addition to hydraulic dredging for removal. For the 14.41-acre Phase 1 Dredging Area, existing depths of the rivers, proposed dredging depth, and proposed post-dredging depths are depicted in Attachment B of BA developed for the Project (ECORP Consulting, Inc. 2020). This level of detail has not yet been determined for the Phase 2 Future Dredging Area and can be provided once complete.

1.3.2. Dewatering Operations

Dredged material will be placed on land within empty wastewater ponds at the Marysville Wastewater Treatment Plant (WWTP) via a discharge pipeline or via mechanical equipment. The existing wastewater ponds serve as existing confined basins within which water would be decanted from the dredged material and evaporative drying of the dredged material would take place. Progressive surface trenching will be used to mechanically manipulate the dredged material to speed evaporative drying. Settling basins will also be used to clean water drained from sediment before it is discharged back into the Feather or Yuba rivers. A conceptual schematic of the proposed dewatering within the Marysville WWTP wastewater ponds is provided in Attachment C as part of the BA for the proposed Project (ECORP Consulting, Inc. 2020).

Phase 2 dredged material would be dewatered in the Marysville WWTP North Ponds as well, if funding is received in time for use of the Marysville WWTP site. If Phase 2 dredged material cannot be dewatered at the Marysville WWTP, dredged material would be placed into fractionation tanks or other temporary dewatering basins staged at the Yuba City Boat Ramp facility, either via a discharge pipeline or mechanical equipment, where water would be decanted from the dredged material. Fractionation tanks would be manifolded together in series and decanted water would be routed to a filtration system, stored, and tested. It is anticipated that filtered water would then be disposed of either to land or disposed of back into the Feather River.

1.3.3. Dredged Material Disposal Operations

Once the dredged material is determined to meet acceptable water content by the City of Marysville, it will be provided to the City of Marysville for their use in final grading/closure of the northernmost wastewater ponds (North Ponds) at the Marysville WWTP (Figure 1). SBFCA's preferred option is to dispose of all of the dredged material at the Marysville WWTP. If all or portions of the sediment are not able to be disposed of at the Marysville WWTP, the sediment will be hauled to Recology's Ostrom Road Landfill.

1.3.4. Construction Equipment and Staging

Onshore equipment and dredging equipment and vessels may vary depending upon site conditions during construction. However, a list of anticipated equipment and vessels for the Project are listed below. Several support trailers would be required at the Yuba City Boat Ramp facility. Designated equipment storage and staging areas would be established at the Yuba City Boat Ramp facility and/or Marysville WWTP, in addition to the Marysville WWTP (Figure 1). It is assumed that all vessels will enter and exit the river via the Yuba City boat ramp. All staging and storage, including access to the area to be dredged, will occur at previously established sites. Therefore, there is no new construction or land disturbing activities proposed for equipment storage or staging.

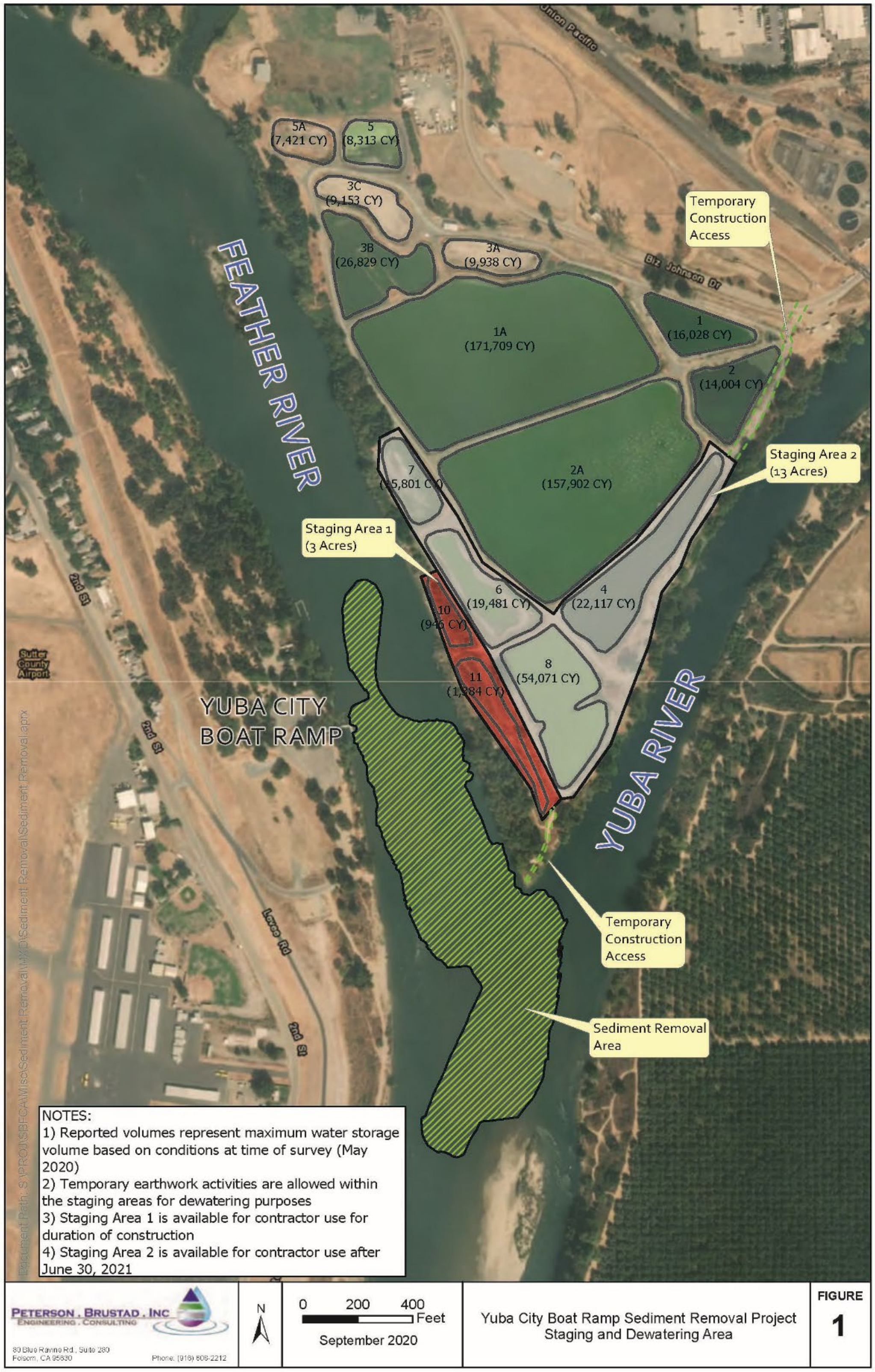

Figure 1. Project Location with Staging and Dewatering Areas

Construction Equipment List:

- **Onshore Equipment**
  - Crane (1)
  - Forklifts (2)
  - Rubber tired rotary trencher (1)
  - Rubber tired dozers (2)
  - Tractors/loaders/backhoes (2)
  - Grader (1)
  - Water trucks (1)
- **Dredging Vessels and Equipment**
  - Dredge vessel (mechanical or hydraulic)
  - Transport barge
  - Towboats (2)
- **Support Vessels and Equipment**
  - Swift water rescue boat
  - Support boat for environmental monitoring
  - Light plants (10)

1.3.5. Project Timing and Sequence

Dredging operations and dewatering activities are proposed to be limited to between June 15 and October 15 to align with work windows to avoid impacts to special-status fish species. The remainder of the construction period would be dedicated to pre-construction surveys, mobilization and demobilization activities, and completion of the transfer of dewatered dredged material to the City of Marysville for their use in decommissioning of the WWTP.

Completion of Phase 1 of the proposed Project is anticipated to occur in one season, in 2021. Completion of Phase 2 of the proposed Project could occur in 2021, but is likely to conclude in 2022/2023, due to the timing of funding for this Phase and the number of truck trips associated with disposal of the dredged material. It is assumed that nighttime operations may be required for the Project.

1.3.6. Avoidance and Minimization Measures Proposed During Construction

The following avoidance and minimization measures (AMMs) will be implemented during construction:

1. All in-water work will be limited to the time period between June 15 and October 15 (in-water work window) when ESA-listed anadromous fishes are least likely to be present in the Action Area within the lower Feather and Yuba rivers.
2. Deploy a turbidity curtain in the Project Area during dredging activities to reduce sediment resuspension.
3. If and where mechanical dredging is used, attempt to exclude fish from the area using block nets.

4. Employ a fish biologist to be onsite as needed to monitor dredging activities and check the exit end of the suction pipe and spoils (*i.e.*, sediment and vegetation).
5. Erosion control measures will be placed between Waters of the U.S. and the outer edge of the staging and dewatering areas, within an area identified with highly visible markers (*e.g.*, construction fencing, flagging, silt barriers) prior to commencement of construction activities. Such identification and erosion control measures will be properly maintained until construction is completed and the soils have been stabilized.
6. Any fueling in the upland portion of the Project Area will use appropriate secondary containment techniques to prevent spills.
7. A qualified biologist will conduct a mandatory Worker Environmental Awareness Program for all contractors, work crews, and any onsite personnel on the potential for special-status species to occur on the Project site. The training will provide an overview of habitat and characteristics of the species, the need to avoid certain areas, and the possible penalties for non-compliance.
8. A qualified biologist/biological monitor will be onsite during daily construction activities to ensure compliance with the anticipated terms and conditions of the Project regulatory permits and California Environmental Quality Act (CEQA) compliance document. If appropriate, the approved biologist will train an individual to act as the onsite construction monitor for periods when there is a low risk of effects to special-status species.
9. The proposed action would comply with all terms and conditions of the regulatory permits including: Section 404 Permit from the Corps, Section 401 water quality certification from the Central Valley Regional Water Quality Control Board, Section 1602 Streambed Alteration Agreement from the California Department of Fish and Wildlife (CDFW), and, if necessary, an Incidental Take Permit 2081 from CDFW, pursuant to Section 2080 of the California Fish and Game Code.
10. A qualified biologist/biological monitor will be onsite during daily construction activities to conduct water quality monitoring within the Feather River upstream and downstream of the construction area. A comprehensive water quality monitoring plan is provided as Attachment F in the BA associated with the Project (ECORP Consulting, Inc. 2020).

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

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

2.1. Analytical Approach

This 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 relies on the 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 designation(s) of critical habitat for (species) use(s) the term primary constituent element (PCE) or essential features. The 2016 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 2019 regulations define effects of the action using the term "consequences" (50 CFR 402.02). As explained in the preamble to the regulations (84 FR 44977), that definition 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 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 would be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. 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" as described in 50 CFR 402.02. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

This biological opinion analyzes the effects of the proposed action on the following evolutionarily significant units (ESUs) and distinct population segments (DPS): the threatened CV spring-run Chinook salmon ESU (*Oncorhynchus tshawytscha*), the threatened CCV steelhead DPS (*O. mykiss*), and threatened sDPS green sturgeon (*Acipenser medirostris*). See Table 2 for species and Table 3 for critical habitat information.

Table 1. Description of species, current listing classification, and summary of species status.

Species	Listing Classification and Federal Register Notice	Status Summary
Central Valley spring-run Chinook salmon ESU (CV spring-run)	Threatened, 70 FR 37160; June 28, 2005 (Original listing – 64 FR 50394; September 16, 1999)	According to the NMFS (2016a) 5-year species status review, the status of the CV spring-run Chinook salmon ESU had improved since the 2011 5-year species status review (through 2014), due to extensive restoration and increases in spatial structure of historically extirpated populations (Battle and Clear creeks), which were trending in the positive direction. However, during the 2012 to 2016 drought, researchers observed high pre-spawn and egg mortality and uncertain juvenile survival, and since 2015, researchers have found many of the dependent populations in decline (NMFS 2016a). In 2017, CDFW reported the lowest CV spring-run Chinook salmon escapement ever (CDFW 2018).

Species	Listing Classification and Federal Register Notice	Status Summary
California Central Valley steelhead Distinct Population Segment (CCV steelhead)	Threatened, 71 FR 834; January 5, 2006 (Original listing – 63 FR 13347; March 19, 1998)	According to the NMFS (2016b) 5-year species status review, the status of CCV steelhead has changed little since the 2011 status review, which concluded that the DPS was likely to become endangered within the foreseeable future. Most populations of natural-origin CCV steelhead are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life history diversity of the DPS is mostly unknown, as very few studies have been published on traits, such as age structure, size at age, or growth rates in CCV steelhead.
Southern DPS of North American green sturgeon (sDPS green sturgeon)	Threatened, 71 FR 17757; April 7, 2006	According to the NMFS (2015) 5-year species status review, some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers, but the species viability continues to be constrained by factors, such as a small population size, lack of multiple spawning populations, and concentration of spawning sites into just a few locations. The species continues to face a moderate risk of extinction.

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

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

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

2.2.1. Recovery Plans

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

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

2.2.2. Global Climate Change

One major factor affecting the rangewide status of the threatened and endangered anadromous fish in the Central Valley 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 Chinook salmon in the Central Valley. Because the runs are restricted to low elevations as a result of impassable rim dams, if climate warms by 5°C (9°F), it is questionable whether any Chinook salmon populations in the Central Valley 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). CV spring-run Chinook salmon spawn primarily in the tributaries to the Sacramento River, and those tributaries without cold water refugia (usually input from springs) will be more susceptible to impacts of climate change.

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

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

In summary, observed and predicted climate change effects are generally detrimental to these listed species (McClure *et al.* 2013, Wade *et al.* 2013), so unless offset by improvements in other factors, the status of the species and critical habitat is likely to decline over time. The climate change projections referenced above cover the time period between the present and approximately 2100. While the uncertainty associated with these projections increases over time, the direction of climate change is relatively certain (McClure *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 135.55-acre Project is located at the confluence of the Feather and Yuba rivers in the cities of Yuba City, California and Marysville, California in Sutter and Yuba counties, respectively.

The Action Area includes the lower Feather River within the boundary of the proposed dredging activity (Figure 2. Project Components), including the riverbed and banks of the Feather River within the footprint of the proposed dredging activity up to the ordinary high water mark. Resuspension of sediments and associated increased turbidity levels resulting from removal of benthic sediments may adversely affect fish within the Action Area. In addition, discharge of decanted return water from sediment dewatering may affect water quality downstream of the point(s) of discharge within the Feather or Yuba rivers. As such, the Action Area also encompasses the entire width of the Feather River and Yuba River channels to a distance of 500 feet downstream of the dredging area boundary. This also includes areas downstream of any points of return water discharge, in which elevated levels of turbidity, suspended sediment load, or disturbance may occur during dredging of sediments and removal of invasive vegetation.

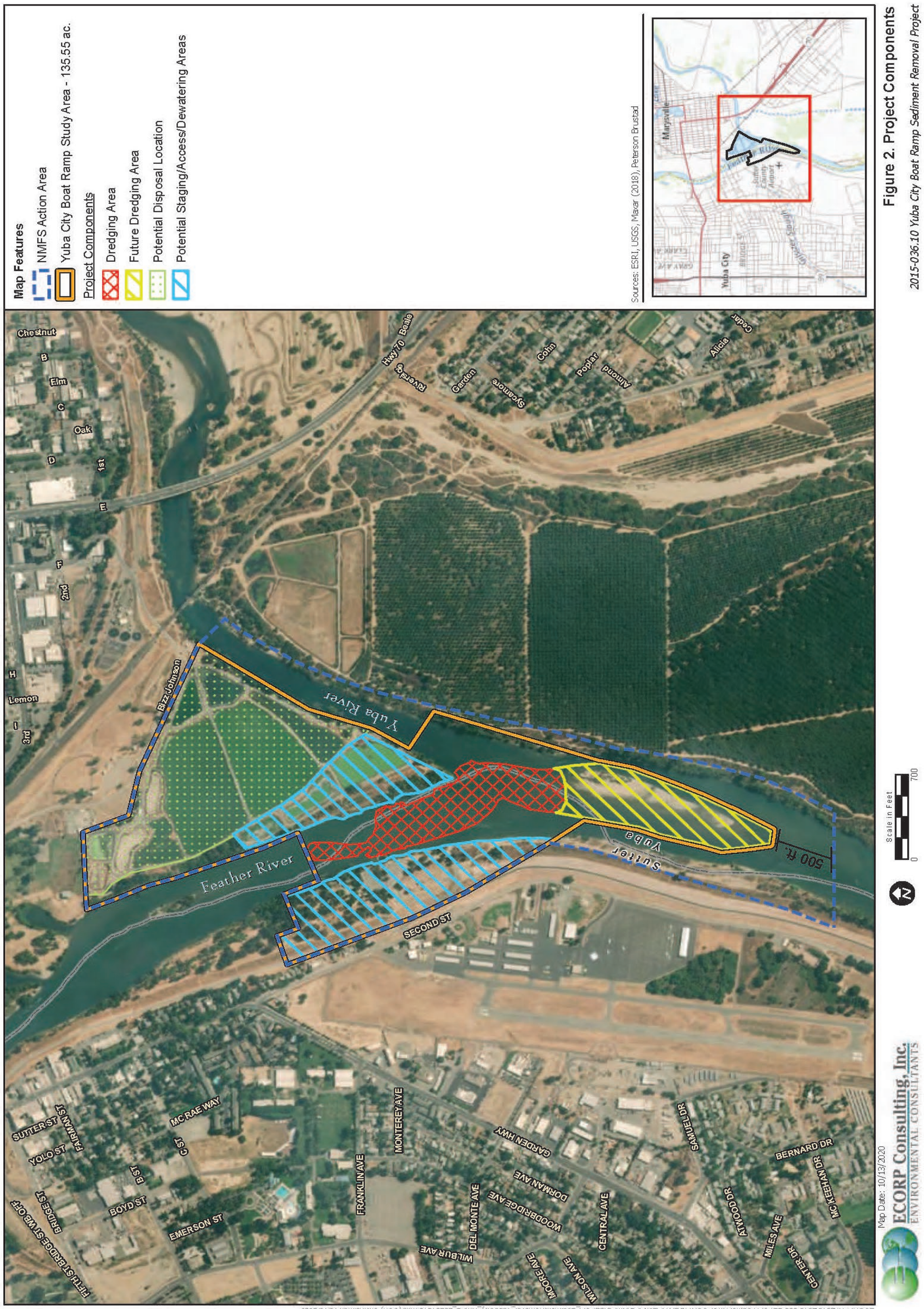

Figure 2. Project Components and Action Area

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).

The Feather River is the largest tributary of the Sacramento River located in California's Central Valley. The Feather River has undergone many changes from its historical condition. These changes began in earnest with the California Gold Rush, and continued with the development of man-made dams and other structures to control the flow, storage, and transport of water, and the development of hydroelectric power. The largest dam on the Feather River, and in fact the tallest dam in the United States, is Oroville Dam. Oroville Dam was completed in 1968 as the centerpiece of the State Water Project (SWP). Oroville Reservoir has the second largest storage capacity of California reservoirs at approximately 3.5 million acre-feet. In addition to water storage and conveyance for use in the SWP, the dam and associated facilities generate power and provide flood protection for downstream communities. Additionally, the reservoir provides a variety of recreational opportunities for the public. In general, winter and spring-runoff is stored in Oroville Reservoir and water is released in late spring and summer for diversion at the South Sacramento-San Joaquin River Delta (Delta) pumps and to maintain water quality conditions in the Delta.

The Yuba River watershed drains approximately 1,340 square miles covering Sierra, Placer, Yuba, and Nevada Counties. The water flows west from the Sierra Nevada Mountain range carrying melted snow run-off and water from the three upper Yuba River forks down to the confluence with the Feather River. While the location of the project is in the lower Yuba River at the confluence with the Feather River, the overall watershed plays a large role in water quality and quantity in the project area. Multiple factors affect the water quality of the lower Yuba River, including hydroelectric power generation, diversion for water supply, dams and reservoirs, mining activities, urbanization, and timber harvesting.

2.4.1. Lower Feather River

The Lower Feather River is generally considered as that portion of the Feather River and its watershed that lies downstream of Oroville Dam, extending to the confluence with the Sacramento River at Verona. The Lower Feather River watershed encompasses about 803 square miles. There are approximately 190 miles of major creeks and rivers, 695 miles of minor streams, and 1,266 miles of agricultural water delivery canals. The river flows approximately 60 miles north to south before entering the Sacramento River at Verona. The river is almost entirely contained within a series of levees as it flows through the agricultural lands of the Sacramento Valley. Oroville Dam is a major component of the SWP, and it provides virtually all the water delivered by the California SWP. Flows are regulated for water supply and flood control through releases at Oroville Dam, and to a lesser extent, flows are regulated to maximize production of hydroelectric power.

The fish habitat in the Lower Feather River below the Fish Barrier Dam is generally divided into the Low Flow Channel (LFC) and the High Flow Channel (HFC) based on differences in flow and habitat conditions. The LFC is an 8.1 mile section between the Fish Barrier Dam and the Thermalito Afterbay Outlet, where discharge is mostly stable at 600-800 cfs, except under flood conditions or when flow increases are needed for river temperature management. The HFC is a 59-mile section of the river between the Thermalito Afterbay Outlet and the confluence with the Sacramento River. The flows and temperatures in the HFC are greater and fluctuate more, relative to the LFC (Seesholtz *et al.* 2004). The LFC in comparison to the HFC has a higher gradient, cooler summer and fall water temperatures, and a lower, more stable flow level. Native fishes, particularly anadromous salmonids, are observed more frequently in the LFC while non-native fishes including piscivorous striped bass (*Morone saxatilis*) and black bass (*Micropterus* spp.) tend to be observed more frequently in the HFC (Seesholtz *et al.* 2004). Both reaches have degraded native fish habitat conditions as a result of anthropogenic activities including bank protection, gravel mining and dredging, loss of bed material recruitment, riparian vegetation removal, diversions, flow regulation, and flood control (Buer *et al.* 2004; Williams *et al.* 2016).

2.4.2. Status of the Species and Critical Habitat within the Action Area

The Feather River below Oroville Dam supports populations of multiple anadromous fishes that are listed as threatened, including CCV steelhead, CV spring-run Chinook salmon, and sDPS green sturgeon. These species are entirely dependent on flow releases to the Lower Feather River from Oroville Dam. Additionally, the Feather River Hatchery (FRH) was constructed in 1967 to mitigate for fish production that was lost due to the construction of Oroville Dam. Central Valley fall-run Chinook salmon (*O. tshawytscha*), CV spring-run Chinook salmon, and CCV steelhead are currently produced annually at the FRH.

The lower Yuba River provides an important upstream and downstream migration corridor for adult and juvenile CV spring-run Chinook salmon and CCV steelhead and rearing habitat for juvenile CV spring-run Chinook salmon and CCV steelhead. Southern DPS green sturgeon utilize the lower Yuba River as a migration corridor and for non-natal rearing.

2.4.2.1. Central Valley spring-run Chinook salmon

In the Action Area, the CV spring-run Chinook salmon ESU includes all naturally spawned populations of spring-run Chinook salmon from the Feather and Yuba rivers, as well as fish from the FRH. NMFS' Central Valley Technical Recovery Team (TRT) believes that the existing CV spring-run Chinook salmon population in the Feather River, including the hatchery fish, may be the only remaining representatives of an important component of the ESU, and that the FRH spring-run Chinook salmon stock may play an important role in the recovery of CV spring-run Chinook salmon in the Feather River Basin (Lindley *et al.* 2004, FERC 2007).

Since the construction of Oroville Dam, fish passage has been halted on the Feather River at the Fish Barrier Dam. For the CV spring-run Chinook salmon that now return to the river, their options are to either spawn naturally in the river, utilizing the remaining habitat in the lower reaches of the Feather River below the Fish Barrier Dam, or to ascend the fish ladder which begins at the Fish Barrier Dam and enters the FRH where the fish are then artificially propagated.

There are multiple issues of concern with both the FRH and the naturally spawning fish in the river. The primary problem is the overlap in time and space with fall-run Chinook salmon, leading to hybridization between the two runs in the river. Past hatchery practices that historically led to mixing and interbreeding of the two runs within the hatchery has also played a role. Although hatchery practices have improved, and strong efforts are made to differentiate and separate CV spring-run Chinook salmon from fall-run Chinook salmon in the Feather River, it is likely that CV spring-run Chinook salmon in the Feather River have nevertheless been compromised such that their genetics are something of a mix between fall-run and CV spring-run Chinook salmon. While hatchery practices may be able to alleviate some of the problems of genetic mixing of the two runs, those fish that spawn in the river are still able to mix and interbreed, likely resulting in redd superimposition and increased genetic introgression.

Other anthropogenic activities that have impacted CV spring-run Chinook salmon include modification of the hydrograph, loss of sediment and large wood transport, restriction of lateral movement of the river channel, mining, unscreened water diversions, and riparian vegetation removal. Changes in the hydrograph can influence the duration of downstream migration, exposing migrating salmonids to increased predation. Changes in the hydrograph can also reduce lateral movement of the river. This along with the loss of sediment and large wood transport downstream of Oroville Dam has likely resulted in decreases in habitat value for CV spring-run Chinook salmon spawning and rearing. Mining, levee and dike construction, and removal of riparian vegetation have also resulted in adverse effects to habitat for spawning and rearing salmonids. Unscreened water diversion may entrain salmonids and result in the loss of a significant number of CV spring-run Chinook salmon.

Spring-run Chinook salmon begin their migrations into the Sacramento River from March through September (Reynolds *et al*. 1990), but peak abundance of immigrating adults in the Sacramento-San Joaquin Delta (Delta) and lower Sacramento River occurs from April through June. Adult spring-run Chinook salmon migrate into natal streams (*i.e*., the upper Sacramento River and tributaries), where they hold in deep water habitats downstream of spawning grounds during the summer months until their eggs fully develop and become ready for spawning. Spawning occurs during mid-August through early October (Reynolds *et al*. 1990). A small portion of an annual year-class may emigrate as post-emergent fry (less than 45 millimeters [mm] total length [TL]) and reside in the Delta undergoing smoltification. However, most are believed to rear in the upper river and tributaries during the winter and spring, emigrating as juveniles (greater than 45mm TL; not having undergone smoltification) or smolts (silver-colored fingerlings having undergone smoltification). The timing of juvenile emigration from the spawning and rearing reaches varies among the tributaries of origin, and can occur from November through June, during which period juvenile spring-run Chinook salmon may occur in the Action Area.

Adult spring-run Chinook salmon migrate through the Action Area and into the lower Yuba River from March through July and hold in deep pools, including the Daguerre Point Dam plunge pool and the Narrows Reach downstream of Englebright Dam during the summer months (CDFG 1991). Monitoring of fish passage through the fish ladders at Daguerre Point Dam indicated that an average of 1,589 adult spring-run Chinook salmon migrated past the dam during the three-year monitoring period of 2010-12. Chinook salmon spawning occurs from early or mid-September into November (Yuba County Water Agency [YCWA] 2013a). Redd surveys indicate that the majority (greater than 74 percent) of all Chinook salmon redds were established between Daguerre Point Dam and Englebright Dam (YCWA 2012).

The Feather River downstream of Fish Barrier Dam is designated critical habitat for CV spring-run Chinook salmon (70 FR 52488; September 2, 2005). This also includes the portion of the lower Yuba River within the Action Area. The critical habitat designation also describes PBFs for CV spring-run Chinook salmon critical habitat. Within the Action Area, the following PBFs are present:

Freshwater Rearing Habitat: PBFs for CV spring-run Chinook salmon include freshwater rearing sites with water quantity and floodplain connectivity to form and maintain physical habitat conditions and support juvenile growth and mobility; water quality and forage supporting juvenile salmonid development; and natural cover such as shade, submerged and overhanging large wood, log jams and beaver dams, aquatic vegetation, large rocks and boulders, side channels, and undercut banks (70 FR 52488; September 2, 2005). Both spawning areas and migratory corridors comprise rearing habitat for juveniles, which feed and grow before and during their outmigration. Non-natal, intermittent tributaries also may be used for juvenile rearing. Rearing habitat condition is strongly affected by habitat complexity, food supply, and the presence of predators of juvenile salmonids. The LFC has many of these features. The HFC has less habitat complexity and is channelized, leveed, and riprapped and offers little protection from piscivorous fish and birds. Freshwater rearing habitat has a high intrinsic value for the conservation of the species even if the current conditions are significantly degraded from their natural state.

Freshwater Migration Corridors: PBFs for CV spring-run Chinook salmon include freshwater migration corridors free of migratory obstructions and excessive predation with water quantity and quality conditions and natural cover such as submerged and overhanging large wood, aquatic vegetation, large rocks and boulders, side channels, and undercut banks that support juvenile and adult mobility and survival (70 FR 52488; September 2, 2005). Migratory corridors are downstream of the spawning areas and include the HFC. The HFC allows the upstream passage of adults and the downstream emigration of juveniles. There are a number of unscreened diversions in the HFC. For juveniles, unscreened or inadequately screened water diversions throughout their migration corridors and a reduction of complex in river cover have degraded this PBF in the HFC. However, since the primary migration corridors are essential for connecting early rearing habitat with the ocean, even the degraded reaches are considered to have a high intrinsic value for the conservation of the species.

2.4.2.2. California Central Valley steelhead

The CCV steelhead DPS final listing determination was published on January 5, 2006 (71 FR 834) and included all naturally spawned populations of CCV steelhead (and their progeny) below natural and manmade barriers in the Sacramento and San Joaquin Rivers and their tributaries, including the Feather and Yuba rivers. FRH CCV steelhead are also included in this designation. The current Feather River CCV steelhead population appears to be almost entirely supported by the FRH and is restricted to the river reaches downstream of the Fish Barrier Dam (river mile [RM] 67). The lower Yuba River within the Action Area is used as a migration corridor for adult and juvenile CCV steelhead.

Historical accounts rarely mention CCV steelhead distribution and abundance in the Feather River Basin. Based on creel surveys and interim trap counts at the Oroville Dam site, the California Department of Fish and Game estimated that at least 2,000 CCV steelhead passed into the habitat upstream of Oroville Dam (Wooster 1966). From run years 1963 to 1966, the trap counts of CCV steelhead passed upstream of the dam construction site were 416, 914, 434, and 563, respectively (Wooster 1966). However, because CCV steelhead have similar spawning and rearing preferences as CV spring-run Chinook salmon, the two species are believed to have occupied the same areas with the exception that CCV steelhead are thought to have migrated further upstream in the watershed (CDWR 2007). Due to the construction and operation of hydropower projects (*i.e.*, Oroville Dam and the Fish Barrier Dam), the upper Feather River basin is no longer accessible to CCV steelhead. The FRH was designed and is operated to replace reduced CCV steelhead production, attributable to the construction of the Project facilities.

Adult steelhead averaging 600 to 800 mm in length (Moyle 2002) leave the ocean and begin upstream migration through the Delta to spawning reaches in the upper Sacramento and San Joaquin rivers and tributaries, typically from August through March (McEwan 2001), with peak immigration occurring in January and February (Moyle 2002). Spawning generally occurs from January through April (McEwan and Jackson 1996). Juvenile steelhead rear in their natal streams for one to three years prior to emigrating from the river. Emigration of one- to three-year old, subadult fish occurs primarily from January through June (Snider and Titus 1996). The life history timing of steelhead in the lower Yuba and lower Feather rivers are assumed to be similar. Adult steelhead migrate into the lower Yuba River from August through March (YCWA 2013a). Spawning generally occurs from January through April (YCWA 2013b) and embryo incubation lasts from January through May. Juvenile steelhead rear in their natal streams for one to three years prior to emigrating. Steelhead kelts (post-spawning adults) may be present in the in the Action Area during their return to the ocean shortly after spawning (*i.e.*, January through mid-April).

Critical habitat for CCV steelhead was designated on September 2, 2005 (70 FR 52488), and includes the Feather River from its confluence with the Sacramento River upstream to the Fish Barrier Dam at RM 67. The critical habitat designation also describes PBFs for CCV steelhead critical habitat. Within the Action Area, these PBFs include: 1) freshwater rearing areas and 2) a freshwater migration corridor. The conditions of the PBFs for CCV steelhead in the Feather River are the same as for CV spring-run Chinook salmon. Although habitat conditions within the Action Area are degraded, the importance of this area for the conservation of CCV steelhead is considered high. This is mainly due to the fact that there is very little suitable steelhead habitat remaining in the Central Valley and any habitat that is currently available has a high value for the conservation of the DPS.

2.4.2.3. Southern DPS green sturgeon

Green sturgeon are long-lived and widely ranging across the North American west coast, but the sDPS breeds exclusively in the freshwater rivers of California, predominantly in the Sacramento River, and to a smaller extent in the Feather River. Some sDPS green sturgeon spawning activity has also been noted in the Yuba River (CDFW 2018, 2019). Known spawning locations for sDPS green sturgeon in the Central Valley include the Sacramento River downstream of Keswick Dam, in the Feather River near the Thermalito Bay outlet (Seesholtz *et al.* 2015), and in the lower Yuba River downstream of Daguerre Point Dam (CDFW 2018, 2019).

The Feather River contains at least two known sDPS green sturgeon spawning areas, and also provides for a migratory corridor to access the Yuba River. Adult green sturgeon have been observed in the plunge pool below Daguerre Point Dam in May 2011 (CDFW 2018; Cramer Fish Sciences 2011), in July 2016 (CDFW 2018), and in June-August 2017 (CDFW 2018), May-June 2018 (CDFW 2018), and April-August 2019 (CDFW 2019). In a study to determine green sturgeon spawning in the lower Yuba River below Daguerre Point Dam, approximately 270 green sturgeon eggs were collected on egg mats placed in the pool benthos in June 2018 (CDFW 2018) and one young-of-the-year green sturgeon was captured downstream of the dam in August 2019 (CDFW 2019), thereby indicating successful green sturgeon spawning in the lower Yuba River.

Adult green sturgeon move into estuaries and lower reaches of rivers to feed between mid-February and early May (NMFS 2010). Adults captured in the Delta feed off benthic invertebrates including shrimp, mollusks, amphipods, and small fish (Moyle *et al*. 1992 as cited by NMFS 2015). Tagging studies indicate that migration of adult green sturgeon to upstream spawning reaches and downstream emigrations is rapid, typically occurring over the course of a few weeks (Heublein *et al*. 2008). Spawning occurs from April through early July in deep (>three meters), cool (50 to 63.7°F), and turbulent rivers (Van Eenennaam *et al*. 2005; Poytress *et al*. 2010, 2011) over substrates ranging from clean sand to bedrock, but typically dominated by cobbles (Moyle 2002). Following spawning, adult green sturgeon may hold for several months in deep pools or near spawning sites, followed by downstream migration to overwintering and rearing locations as flows increase in the fall months (NMFS 2010) and temperature decrease. Data from the California Fish Tracking Database (2015) indicate that ocean re-entry occurs primarily from November through January.

Based on their similarity to white sturgeon (*A. transmontanus*), eggs are believed to hatch within approximately 200 hours at 55°F, (Emmett *et al*. 1991; Moyle 2002). Young-of-the-year fish grow quickly and have a relatively short residence time in riverine environments (Van Eenennaam *et al*. 2006) before they emigrate downstream toward the Delta/Estuary, feeding primarily on opossum shrimp (*Neomysis mercedis*) and Corophium amphipods (Radtke 1966 as cited in Moyle 2002). Juvenile green sturgeon are believed to reside in freshwater habitats from one to four years, before emigrating to the Delta under winter high-flow events; however, the timing and duration of juvenile emigration to the Delta is unknown (Poytress *et al.* 2011).

Kynard *et al.* (2005) suggested that juvenile sturgeon move downstream to over-wintering and rearing habitats in the fall months when temperatures decreased to less than 50°F.

Critical habitat has been designated for the sDPS of North American green sturgeon and includes riverine habitat from the Feather River's confluence with the Sacramento River, upstream to the furthest accessible point below the Fish Barrier Dam (74 FR 52300; October 9, 2009). Within the Yuba River, critical habitat for sDPS green sturgeon extends upstream and ends at Daguerre Point Dam. Daguerre Point Dam is impassible to adult sDPS green sturgeon and blocks access to historical upstream sDPS green sturgeon spawning habitat (Mora *et al.* 2009). The pool below Daguerre Point Dam may be the only currently accessible location in the lower Yuba River where depth, substrate type and size, and water flow may be conducive to green sturgeon spawning. The rest of the lower Yuba River, including the Action Area, has been highly modified by anthropogenic activities and likely only serves as a migratory corridor for sDPS green sturgeon migration.

PBFs for riverine systems include features related to passage of sDPS fish to spawning sites and suitable habitat necessary for each riverine life stage (*e.g*., spawning, egg incubation, larval rearing, juvenile feeding, and passage throughout the river). The PBFs for sDPS green sturgeon critical habitat referenced in Section 2.2 *Rangewide Status of the Species and Critical Habitat* that are specific to riverine systems apply in the Feather River. These include:

- food resources
- substrate type or size
- water flow
- water quality
- migratory corridor
- water depth
- sediment quality

Southern DPS green sturgeon require adequate food resources and spawning substrate. A migratory corridor that is attractive to sDPS green sturgeon is necessary for sDPS green sturgeon to access spawning grounds and to access other tributaries, such as the Yuba River. Pool depths of equal to or greater than 5 meters appear important for holding and spawning. Sediment quality must be sufficient for all life stages. Flows from the Yuba River can also be an important contribution to the HFC flows. Currently, we do not fully understand how sDPS green sturgeon respond to the differences in flows and water temperatures between the Feather and Yuba rivers.

2.4.3. Factors Affecting Species and Critical Habitat in the Action Area

Dams have eliminated access to historic holding, spawning, and rearing habitat and have resulted in CV spring-run Chinook salmon and fall-run Chinook salmon spawning and rearing in the same areas, at the same times. This has resulted in increased competition, superimposition of redds, and interbreeding of the two populations. Oroville Dam has also modified the hydrograph of the river, which has led to reduced lateral movement of the channel. This, and the loss of sediment and large wood transport downstream of Oroville Dam, has resulted in decreases in habitat value for salmonid spawning and rearing.

Mining, levee and dike construction, and removal of riparian vegetation have also resulted in adverse effects to habitat for spawning and rearing salmonids. Bank modification (the construction of levees and bank armoring) has changed the geomorphic processes affecting the lower Feather River. Riparian vegetation is important to aquatic habitats because it provides overhanging cover for rearing fish, streamside shading, and a source of terrestrial and aquatic invertebrate contributions to the fish food base. Riparian vegetation is also an important source of future large woody material contributions to the aquatic system. Removal of vegetation through bank modification has reduced habitat quality and the productivity of the lower Feather River. Also, unscreened water diversion may entrain salmonids and result in the loss of a significant number of CV spring-run Chinook salmon and CCV steelhead. The result of these changes has been the reduction in quantity and quality of several essential features of migration and rearing habitat required by juveniles to grow and survive. In spite of the degraded condition of this habitat, the intrinsic value of the action area for the conservation of the species is high as it is used by two Federally-listed salmonids in the Central Valley.

The Feather River population of CV spring-run Chinook salmon continues to have high returns (1,000-20,000), but is heavily influenced by the FRH. The population spawning in-river is difficult to determine because they are not counted when entering, and monitoring during spawning results in difficulties distinguishing between races. Adults returning to the FRH that are collected for propagation have remained fairly consistent, generally between 1,000 to 4,000 fish. The proportion of hatchery-origin spring- or fall-run Chinook salmon contributing to the natural spawning spring-run Chinook salmon population in the Feather River remains unknown due to overlap in the spawn timing of spring-run and fall-run Chinook salmon, and lack of physical separation. However, carcass surveys indicate a large percentage of the spawning adults are likely of hatchery origin (NMFS 2016b). Escapement of CCV steelhead to the FRH has been quite variable over the years, generally averaging about 1,100 fish. Currently, nearly all the steelhead that return to the FRH are hatchery-origin fish, indicating that spawning and/or rearing habitat for steelhead in the Feather River is very poor and natural production is limited (NMFS 2016a).

The Action Area is also within designated critical habitat for sDPS green sturgeon. As is the case with salmonids, PBFs in the area have been severely impaired through several anthropogenic factors. The loss of potential upstream habitat from Oroville Dam, altered hydrograph, altered temperature regime, other changed or degraded environmental or habitat conditions, overfishing, poaching, diversions of water, predation, ocean survival, and other factors have greatly impacted the sDPS green sturgeon in the Feather River.

A migratory corridor with adequate flows resulting in unimpeded passage for sDPS green sturgeon is necessary for access to spawning grounds in the Feather River and other tributaries like the Yuba River that may also serve as spawning habitat. Presently, a rock weir at Sunset Pumps is believed to impair upstream fish passage of sDPS green sturgeon at low flows. Additionally, habitat conditions necessary to support a healthy population of sDPS green sturgeon in the Feather River are influenced by a variety of other impacts, such as sport fishing regulations, water diversions, levee maintenance, construction, and contributions from tributaries, such as the Yuba River. Dual-Identification Sonar (DIDSON) surveys from 2011-2013 documented variable numbers of green sturgeon present in the Feather River, but at least three were present each year, with one year confirming 21- 28 sturgeon present. Green sturgeon have also been observed spawning in the Feather River (NMFS 2015). Utilization of the area by several green sturgeon life stages means the habitat is still of high value for the conservation of the species.

During February 2017, heavy precipitation and high flows in the Feather River basin resulted in extensive erosion and damage to the main Flood Control Spillway and Emergency Spillway area at the Feather River Hydroelectric Project's (Project) Oroville Dam in Butte County, California. The California Department of Water Resources (DWR) first observed major damage to the main Flood Control Outlet Spillway on February 7, 2017, which included a large area of foundation erosion and concrete chute loss in the mid-section of the main Flood Control Outlet Spillway. Due to high inflows into Lake Oroville and reduced outflow capacity on the main Flood Control Outlet Spillway, Lake Oroville overtopped the adjacent Emergency Spillway on February 11, 2017, causing back-cutting erosion below the Emergency Spillway. The back-cutting erosion threatened the stability of the Emergency Spillway's crest structure. As such, DWR increased operation of the damaged Flood Control Outlet Spillway to relieve pressure on the Emergency Spillway, which led to the loss of the lower portion of the main Flood Control Outlet Spillway chute. This caused significant erosion under and adjacent to the Flood Control Outlet Spillway. Impacts were most severe in the Thermalito Diversion Pool immediately below the spillways, but turbidity and fluctuating flows also affected the Lower Feather River extensively downstream beyond the Fish Barrier Dam.

In response to the Oroville Dam Spillway Incident, DWR and CDFW mobilized significant personnel and resources to implement fish rescues. The effort included flying the river on multiple days to identify stranding pools using real-time mapping so crews could be deployed to over 50 miles of river daily to areas in most need of rescue efforts. DWR and CDFW continued to perform fish rescues as additional flow reductions occurred to protect the damaged Flood Control Outlet Spillway. As rescue efforts progressed through the season, fewer and fewer fish were found in stranding pools. The results of these fish rescues are described in White *et al*. (2017). To summarize, Central Valley spring-run Chinook salmon are estimated to have comprised approximately 1.6 percent of the Chinook salmon encountered during rescue efforts. The vast majority of Chinook salmon encountered were Central Valley fall-run Chinook salmon. Additionally, approximately 87 CCV steelhead were collected during rescue efforts, 41 percent of which were adipose fin clipped, indicating they were hatchery-origin steelhead from the FRH.

Another consequence of the Oroville Dam Spillway Incident was the mobilization of suspended sediment and spawning gravel during extremely high flows released during the emergency. DWR has implemented a number of Conservation Measures to improve habitat conditions in the Feather River following the Spillway Incident. In August 2017, DWR completed the addition of 5,000 cubic yards of spawning gravel in the Low Flow Channel of the Feather River to benefit both Central Valley spring-run Chinook salmon and CCV steelhead. DWR also removed a gravel plug from Moe's Side Channel in order to reconnect the channel to the Feather River and restore the channel's normal function.

2.4.4. Summary

Many of the alterations of the Feather River have resulted in negative effects to ESA-listed anadromous fish species and their designated critical habitats. For example, barriers to fish passage prevent ESA-listed anadromous fish from utilizing habitat that they previously occupied. This results in a reduction in habitat. CV spring-run Chinook salmon have not only lost access to habitat, but they have lost genetic integrity due to intermingling with fall-run Chinook salmon. Losses are also expected from superimposition of fall-run Chinook salmon redds on top of spring-run Chinook salmon redds, resulting in increased egg mortality. Dams have not only blocked fish migrations, but also interrupted natural processes, such as the movement of gravel and large woody material. This has degraded the quality of the habitat to which ESA-listed anadromous fish species are limited (downstream of Oroville Dam). Hatchery operations have resulted in domestication of fish, such that they are not as successful in the wild. This also negatively impacts fish in the wild through interbreeding between wild and hatchery fish. Water management has affected habitat quality through lack of channel forming flows, and changes in the hydrograph. Dikes, levees, and flood management have also impacted habitat and natural channel forming processes. Water temperatures have also been modified from historic conditions; however, these changes have some beneficial effects. Areas to which fish, such as CV spring-run Chinook salmon, are now restricted likely have cooler temperatures than prior to the construction of the Project facilities. However, downstream of the Thermalito Afterbay Outlet water temperatures may be warmer, due to the effects of the Thermalito facilities.

There are a number of factors for which data is not available, and for which the effects of multiple activities are intermixed and complex. For example, predation effects on ESA-listed anadromous fish in the Feather River have not been quantified. Looking at survival between fish released at the hatchery and fish released in San Pablo Bay, the differences may be due to predation. However, it is not possible to determine if the predation is worse than it was prior to the effects of various actions in the Feather River, because there is no data to support such a determination. In addition, some of the differences in survival may be due to other factors, such as water diversions, and/or pollution, and/or lack of floodplain rearing, and/or reduced flows during times when juvenile fish are migrating downstream. Additionally, the difference in survival based on release location is variable.

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. 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 50 CFR 402.17(a) and (b).

Dredging operations and dewatering activities are proposed to be limited to between June 15 and October 15 to align with in-water work windows to avoid impacts to ESA-listed fish species. The remainder of the construction period would be dedicated to pre-construction surveys, mobilization and demobilization activities, and completion of the transfer of dewatered dredged material to the City of Marysville for their use in decommissioning of the WWTP.

Completion of Phase 1 of the proposed Project is anticipated to occur in one season, in 2021. Completion of Phase 2 of the proposed Project could occur in 2021, but is likely to conclude in 2022/2023, due to the timing of funding for this Phase and the number of truck trips associated with disposal of the dredged material. It is assumed that nighttime operations may be required for the Project.

If it is determined that both Phase 1 and Phase 2 dredging operations can be completed in a single season, then the in-water work window may be extended to November 30. If this occurs, in-water work will only be conducted during daylight hours from the period of October 15-November 30, to allow for a period of unimpeded migration through the Action Area during nighttime hours.

2.5.1. Turbidity

Dredging has the potential to disturb and suspend a significant volume of benthic sediment. Previous estimates of dredge-created turbidity have indicated that dredging can result in an increase in total suspended solids downstream of the dredging action. Quantifying turbidity levels, and their effect on fish species, is complicated by several factors. First, turbidity from an instream activity will typically decrease as distance from the activity increases. How quickly turbidity levels attenuate depends on the quantity of materials in suspension (*e.g*., mass or volume), the particle size of suspended sediments, the amount and velocity of ambient water (dilution factor), and the physical/chemical properties of the sediments. Second, the impact of turbidity on fishes is not only related to the turbidity levels, but also the particle size of the suspended sediments.

For salmonids, the moderate levels of turbidity expected to be generated by the proposed Project may elicit a number of behavioral and physiological responses (*i.e*., gill flaring, coughing, habitat avoidance, and increase in blood sugar levels) which indicate some level of stress (Bisson and Bilby 1982, Sigler *et al.* 1984, Berg and Northcote 1985, Servizi and Martens 1992). The magnitude of these stress responses is generally higher when turbidity is increased and particle size decreased (Bisson and Bilby 1982, Servizi and Martens 1987, Gregory and Northcote 1993). Although turbidity may cause stress, Gregory and Northcote (1993) have shown that moderate levels of turbidity (35-150 NTU) can accelerate foraging rates among juvenile salmonids, likely because of reduced vulnerability to predators (camouflaging effect).

While use of a clamshell or bucket for mechanical dredging may result in a relatively high degree of spill, use of the cutterhead suction dredge is considered one of the most efficient methods of dredging in terms of sediment re-suspension and associated turbidity increases. Suction dredging has the potential to create turbidity primarily where the excavation is occurring as the interface between the excavating apparatus and sediments is not contained. Any increases in turbidity associated with sediment dredging would be relatively small, localized to within a short distance of the work area, confined to a relatively small area with the turbidity curtain during in-water work, and temporary (*i.e*., 12 hours or less each day). Use of the cutterhead dredge will likely result in elevated turbidity within a few meters of the intake; however, use of a bucket with mechanical dredging has a potential for much larger releases of sediments, resulting in a greater potential for a plume of suspended sediments downstream. Turbidity resulting from dredging and dredged material disposal is expected to be intense in the vicinity of the activities themselves, but would rapidly attenuate with time and space.

Depending on the exact timing of implementation of the proposed action, adult CV spring-run Chinook salmon and CCV steelhead may be present in the Action Area. NMFS expects that most fish will actively avoid areas of elevated turbidity, if possible. Although CV spring-run Chinook salmon and CCV steelhead are highly migratory and capable of moving freely throughout the Action Area, a substantial increase in turbidity may injure fish by temporarily disrupting normal behaviors that are essential to growth and survival such as feeding, sheltering, and migrating. Disrupting these behaviors increases the likelihood that individual fish will face increased competition for food and space, and experience reduced growth rates or possibly weight loss resulting in harm to individuals and increased risk to the affected species. Turbidity increases may also affect the sheltering abilities of some fish and may decrease their likelihood of survival by increasing their susceptibility to predation. Conversely, some turbidity is helpful in reducing predation by shielding the fish from visual predators in a turbid field (Gregory and Levings 1998). For those fish that do not or cannot avoid the turbid water, exposure is expected to be brief (*i.e*., minutes to hours) and not likely to cause injury or death from reduced growth, or physiological stress. However, some juveniles that are exposed to areas of temporarily elevated turbidity may be injured or killed by predatory fish that take advantage of disrupted normal behavior. Once fish migrate past the turbid water, normal feeding and migration behaviors are expected to resume.

The exposure risk to sDPS green sturgeon is less clear. No specific information is available to evaluate the potential responses of sDPS green sturgeon to increased turbidity and suspended sediment. It is possible that higher concentrations of suspended sediment and turbidity may interfere with normal feeding and migratory behavior. However, sturgeon may be less sensitive to short-term increases in suspended sediments or turbidity, because they are a benthically oriented species that are evolutionarily adapted for life in turbid flowing waters and may rely on biomagnetic electroreception or olfactory cues more consistently than vision to locate prey. Any reductions in the availability of foraging habitat and food because of sedimentation of benthic habitat following a dredging episode would likely have little or no effect on growth or survival due to the temporary, localized nature of these effects in an already degraded habitat.

The SBFCA proposes to implement a number of additional techniques to minimize turbidity effects resulting from Project operations. First, turbidity levels would be monitored in accordance with the requirements of the 401 Water Quality Certification (WQC) issued by the Central Valley Regional Water Quality Control Board (CVRWQCB) for the proposed dredging. As described in the Water Quality Plan for the Project (Attachment F in the BA), on all days of in-water work activities, grab samples will be collected prior to commencement of in-water work to establish a baseline, every four hours during in-water work, and upon completion of in-water work for the day. Grab samples will be collected from the water column at approximately mid-depth. To the extent possible, the sampling start time will be varied each day such that samples will be collected at different times to better represent natural variability of the receiving waters (*i.e*., Feather and Yuba rivers). Measurements of turbidity (NTU), dissolved oxygen (DO), pH, and water temperature will be made using a handheld multi-parameter water quality meter (*e.g.*, Horiba U-50). These measurements will be made by staff trained in the proper use and maintenance of the instrument. In the event that monitoring shows that turbidity thresholds established by the WQC are being exceeded, dredging operations would be modified to avoid prolonged negative effects. Second, dredged material would be disposed of in a manner to minimize exposure to ESA-listed species by placing the material in upland disposal sites and by meeting water quality standards for effluent discharge from these sites. Best management practices would be adhered to at disposal locations to prevent remobilization of sediments and subsequent turbidity through dewatering activities or storage.

2.5.2. Contaminants

Disturbing benthic sediments through dredging is expected to mobilize and distribute a variety of contaminants. Some of these contaminants may be acutely or chronically harmful to salmonids (Allen and Hardy 1980). The Corps has tested sediments for contaminants across all areas where dredging is proposed, and has not found contaminants in concentrations that exceed any of the existing regulatory criteria imposed by the requirements for Section 401 WQC under the Clean Water Act. However, some contaminants lack defined regulatory exposure criteria that are relevant to listed anadromous fish that could still result in direct or indirect adverse effects (Ewing 1999).

If contaminants are released during dredging or disposal activities, their effects may be subtle and difficult to directly observe. The effects of bioaccumulation are of particular concern as pollutants can reach concentrations in higher trophic level organisms (*e.g.*, salmonids) that far exceed ambient environmental levels (Allen and Hardy 1980). Bioaccumulation may therefore cause delayed stress, injury, or death as contaminants are transported from lower trophic levels (*e.g.*, benthic invertebrates or other prey species) to predators long after the contaminants have entered the environment or food chain. It follows that some organisms may be negatively affected by contaminants while regulatory thresholds for the contaminants are not exceeded during measurements of water or sediments.

Sublethal or nonlethal effects indicate that death is not the primary toxic endpoint. Rand (1995) stated that the most common sublethal endpoints in aquatic organisms are behavioral (*e.g.*, swimming, feeding, attraction-avoidance, and predator-prey interactions), physiological (*e.g.*, growth, reproduction, and development), biochemical (*e.g.*, blood enzyme and ion levels), and histological changes. Some sublethal effects may result in indirect mortality. Changes in certain behaviors, such as swimming or olfactory responses, may diminish the ability of the salmonids to find food or escape from predators and may ultimately result in death. Some sublethal effects may have little or no long-term consequences to the fish, because they are rapidly reversible or diminish and cease with time. Individual fish of the same species may exhibit different responses to the same concentration of toxicant. The individual condition of the fish can significantly influence the outcome of the toxicant exposure. Fish with greater energy stores will be better able to survive a temporary decline in foraging ability, or have sufficient metabolic stores to swim to areas with better environmental conditions. Fish that are already stressed are more susceptible to the deleterious effects of contaminants, and may succumb to toxicant levels that are considered sublethal to a healthy fish.

Exposure to sublethal levels of contaminants might have serious implications for salmonid health and survival. Studies have shown that low concentrations of commonly available pesticides can induce significant sublethal effects on salmonids. Scholz *et al.* (2000) and Moore and Waring (1996) have found that diazinon interferes with a range of physiological biochemical pathways that regulate olfaction, negatively affecting homing, reproductive, and anti-predator behavior of salmonids. Waring and Moore (1997) also found that the carbofuran had significant effects on olfactory mediated behavior and physiology in Atlantic salmon (*Salmo salar*). Ewing (1999) reviewed scientific literature on the effects of pesticides on salmonids and identified a wide range of sublethal effects such as impaired swimming performance, increased predation of juveniles, altered temperature selection behavior, reduced schooling behavior, impaired migratory abilities, and impaired seawater adaptation.

Other non-pesticide compounds that are common constituents of urban pollution and agricultural runoff also negatively affect salmonids. Exposure to chlorinated hydrocarbons and aromatic hydrocarbons causes immunosuppression and increased disease susceptibility (Arkoosh *et al.* 1994). In areas where chemical contaminant levels are elevated, disease may reduce the health and survival of affected fish populations (Arkoosh *et al.* 1994).

As noted above, the literature suggests that certain contaminants may affect the biology of salmonids. At present, regulatory thresholds are likely inadequate to account for these effects (*i.e.*, some contaminants do not have salmonid exposure criteria or bioaccumulation criteria). Until exposure criteria can be refined and expanded, the SBFCA has committed to implementing conservation measures that are intended to minimize the exposure of listed anadromous fish species to contaminants to the greatest extent possible. For example, measures such as dredging during the in-water work window, continuing to sample sediments for contaminants, refraining from in-water disposal of contaminated sediments, and implementing best management practices to prevent fuel spills, hydraulic leaks, *etc*., during all dredging and disposal operations will be implemented to minimize impacts to ESA-listed species.

As summarized in the Sediment Sampling of Dredged Material section of the BA for the Project (ECORP Consulting Inc. 2020), analyses of sediment grab samples collected in April 2020, in the proposed dredging area detected the presence of barium (42-60 mg/kg total), chromium (17-22 mg/kg total), cobalt (6.6-7.7 mg/kg total), copper (6.3-7.3 mg/kg), nickel (31-41 mg/kg total), vanadium (19-21 mg/kg total), and zinc (15-18 mg/kg total) in concentrations below federal and State (Title 22) criteria for hazardous waste and below screening levels for impacts on aquatic life. All other total petroleum hydrocarbons, semi-volatile organic compounds, organochlorine pesticides, and metals were non-detectable in these samples. As such, resuspension of sediments during dredging is not anticipated to create a plume of pollutants in concentrations that would be hazardous to ESA-listed fishes moving through the lower Feather or Yuba rivers in the Action Area. Furthermore, all equipment refueling and maintenance would occur in an upland area at a sufficient distance to preclude any construction-related hazardous materials from entering the Feather or Yuba rivers and refueling in the upland portion of the Action Area will use appropriate secondary containment techniques to prevent spills. Therefore, based on the factors identified above and the incorporated AMMs, ESA-listed salmonids and sturgeon are not expected to be exposed to project-related contaminants or hazardous materials.

2.5.3. Entrainment and Harassment

Dredging of accumulated sediments within the Action Area would be conducted using large machinery with the potential to entrain, injure, or kill ESA-listed fishes. Specifically, hydraulic and mechanical dredging equipment such as a digging bucket, flat-cut bucket excavator, or cutterhead suction intake are likely to be used during dredging activities. Fish could potentially be physically injured or killed if they come into direct contact with the mechanical dredging equipment.

Disturbance resulting from dredging activities would be short-term (*e.g.*, 12-14 hours per day), during daylight hours to the maximum extent practicable (some nighttime work may be necessary for a portion of the work period to complete the project before October 15). At any given time, the disturbance would be confined to a small footprint around the area being dredged, leaving the majority of the channel unaffected or minimally affected by dredging activities. Furthermore, the presence of a turbidity curtain around the dredging area coupled with noise and activity associated with the dredging activity would likely cause these fish to avoid the immediate construction area by moving downstream a safe distance away from the construction area or by holding upstream of the construction activity until dredging is completed each day and, therefore, are unlikely to be directly injured or killed. Additionally, any avoidance of the Action Area by migrating fish would be short term (*i.e.*, several hours) and would occur during a summer period and time (*i.e.*, during daylight hours) in which ESA-listed salmonids and green sturgeon are unlikely to be present.

The probability of entraining ESA-listed salmonids in either a hydraulic or clamshell dredge is expected to be low, because these fish are likely to avoid the immediate vicinity of dredging operations, and because dredging operations proceed very slowly compared to the swimming ability of salmonids in general. Additionally, the SBFCA has committed to a number of conservation measures to reduce the probability of entrainment occurring during dredging operations. Direct effects to ESA-listed salmonids by entrainment are minimized by keeping the cutterhead in close proximity to the bottom of the water column to the greatest extent practicable. The cutterhead suction pumps would only be turned on when necessary, and only be raised off the channel bottom when necessary during dredging operations. This measure is primarily to protect juveniles from entrainment, as adults have sufficient swimming capacity to avoid entrainment, unless they swim directly into the cutterhead. Overall, no adults and few juvenile CV spring-run Chinook salmon and CCV steelhead are expected to be entrained in the dredge. Any fish entrained in the dredge would be expected to die due to physical injury or suffocation in sediment coupled with the unlikelihood of release back into the river channel once entrained.

During years when successful spawning occurs in the Feather and/or Yuba rivers, juvenile sDPS green sturgeon may be present in the Action Area during their downstream migration. Any juvenile green sturgeon emigrating downstream through the Action Area may be entrained, injured, or killed if they come into close contact with the cutterhead suction intake. Juvenile and adolescent green sturgeon may be at an elevated risk of entrainment from the hydraulic dredge. Based on monitored entrainment rates observed in the Columbia River Basin (Reine and Clark 1998), juvenile white sturgeon (*Acipenser transmontanus*) were entrained by hydraulic dredging at high rates from localized areas known to have aggregations of sturgeon (sturgeon holes). In the Feather and Yuba rivers, known aggregation areas are upstream of the Action Area for the

Project. Therefore, juvenile green sturgeon are not expected to be present in large numbers during dredging activities, reducing the potential for high rates of entrainment. As such, the potential for any green sturgeon to occur in the footprint of the dredging and subject to direct injury or lethality is low.

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 in the environmental baseline (Section 2.4).

Agricultural practices in the Action Area may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow. Grazing activities from cattle operations can degrade or reduce suitable critical habitat for listed salmonids by increasing erosion and sedimentation, as well as introducing nitrogen, ammonia, and other nutrients into the watershed, which then flow into the receiving waters of the associated watersheds. Storm water and irrigation discharges related to both agricultural and urban activities contain numerous pesticides and herbicides that may adversely affect listed salmonid and sDPS green sturgeon reproductive success and survival rates (Dubrovsky *et al.* 1998, Daughton 2003).

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics, and changing both water use and storm water runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those that are situated away from waterbodies, will not require Federal permits, and thus will not undergo review through the ESA section 7 consultation process with NMFS.

Increased urbanization is also expected to result in increased recreational activities in the region. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially suspending contaminated sediments and degrading areas of submerged vegetation. This in turn will reduce habitat quality for the invertebrate forage base required for the survival of juvenile salmonids and green sturgeon moving through the system. Increased recreational boat operation is anticipated to result in more contamination from the operation of gasoline and diesel powered engines on watercraft entering the associated water bodies.

Other projects with the potential to contribute to cumulative or indirect effects on fisheries that may encompass the Action Area include growth-inducing plans (*e.g*., county general plans, specific plans), flood risk management plans (*e.g*., Central Valley Flood Protection Plan), and other Sacramento River and Delta management and restoration plans (*e.g*., California WaterFix, South Delta Improvements Program, California State Water Project, California EcoRestore). While the combined effects of these actions may result in a significant cumulative effect on fisheries, each of these actions have, or will, undergo a separate environmental review and consultation with NMFS and/or USFWS and thus are expected to be mitigated to a less-than-significant cumulative effect. The proposed action is limited in size, would occur during the time period when ESA-listed anadromous fish are least likely to be present, and would comply with all permit terms and conditions to maintain water quality during construction. Therefore, the proposed action is not expected to contribute to significant cumulative effects in the Action Area.

2.7. Integration and Synthesis

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

2.7.1. Summary of the Status of the Species and Environmental Baseline

2.7.1.1. Central Valley spring-run Chinook salmon

Historically, the majority of CV spring-run Chinook salmon in the Central Valley were produced in the Southern Sierra Nevada Diversity Group, which contains the San Joaquin River and its tributaries. All CV spring-run Chinook salmon populations in the Southern Sierra Nevada diversity group have been extirpated (Lindley *et al.* 2007). The Central Valley Technical Recovery Team delineated 18 or 19 historic independent populations of CV spring-run Chinook salmon, and a number of smaller dependent populations, that are distributed among four diversity groups (Lindley *et al.* 2004). Of these independent populations, only three are extant (Mill, Deer, and Butte creeks) and they represent the Northern Sierra Nevada diversity group. The three extant populations passed through prolonged periods of low abundance before increasing in abundance moderately (Mill and Deer creeks) or robustly (Butte Creek) in the 1990s. All independent populations in the Basalt and Porous Lava group and the Southern Sierra Nevada group were extirpated, and only a few dependent populations persist in the Northwestern California group (NMFS 2016a).

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

Past and present impacts within the Sacramento River basin have caused significant loss of habitat. Populations have declined drastically over the last century, and many subpopulations have been extirpated. The construction of dams has limited access to a large and significant portion of historical spawning and rearing. Dam operations have changed downstream flow patterns, affecting stream dynamics (*i.e.*, geomorphology, habitat configuration, *etc*.), and affected available habitat through changes in water temperature characteristics, limiting gravel recruitment to available spawning reaches and limiting the introduction of large woody material which contributes to habitat diversity. Gold mining has occurred in the Feather River, and there are dams (of which Oroville Dam is one of the largest in California), water diversions, and levees.

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

2.7.1.2. California Central Valley steelhead

O. mykiss have long been recognized as having one of the most complex and diverse life histories among all the salmonids. Populations may be entirely anadromous, partly anadromous, or entirely resident, and levels of anadromy can vary by age and sex. One of the difficulties in assessing any steelhead data in the Central Valley is the possibility that some individuals may actually be resident fish, as it is nearly impossible to visually distinguish the two life history forms when they are juveniles. Although not always possible, adult steelhead can sometimes be visually distinguished from resident rainbow trout by assessing characteristics, such as length (*O. mykiss* that are greater than 18 inches are usually considered anadromous steelhead), body depth (steelhead tend to have long, slender bodies, while rainbow trout are shorter in length with rounder bodies), and coloration (silvery, deciduous scales are characteristics of anadromy, whereas darker coloration is more typical for resident fish).

CCV steelhead historically were well-distributed throughout the Sacramento and San Joaquin rivers (Busby *et al.* 1996) and were found from the upper Sacramento and Pit River systems (now inaccessible due to Shasta and Keswick Dams) south to the Kings River and possibly the Kern River systems, and in both east- and west-side Sacramento River tributaries (Yoshiyama *et* *al.* 2001). Lindley *et al.* (2006) estimated that historically there were at least 81 independent CCV steelhead populations distributed primarily throughout the eastern tributaries of the Sacramento and San Joaquin rivers. This distribution has been greatly affected by dams (McEwan and Jackson 1996). Presently, impassable dams block access to 80 percent of historically available habitat, and block access to all historical spawning habitat for about 38 percent of historical populations (Lindley *et al.* 2006).

Most of the steelhead populations in the Central Valley have a high hatchery component, including Battle Creek (adults intercepted at the Coleman NFH weir), the American River, Feather River, and Mokelumne River. Assessing steelhead abundance is confounded by the fact that most of the dedicated monitoring programs in the Central Valley occur on rivers that are annually stocked. Existing wild CCV steelhead stocks in the Central Valley are mostly confined to the upper Sacramento River and its tributaries, including Antelope, Deer, and Mill creeks and the Yuba River. Populations may exist in Big Chico and Butte creeks and a few wild CCV steelhead are produced in the American and Feather Rivers (McEwan and Jackson 1996).

Spatial structure for CCV steelhead is fragmented and reduced by elimination or significant reduction of the major core populations (*i.e.*, Sacramento River, Feather River, American River) that provided a source for the numerous smaller tributary and intermittent stream populations like Dry Creek, Auburn Ravine, Yuba River, Deer Creek, Mill Creek, and Antelope Creek. Tributary populations can likely never achieve the size and variability of the core populations in the long-term, generally due to the size and available resources of the tributaries. Despite the substantial reduction in habitat availability and suitability since the construction of the Oroville Dam facilities, the value of the lower Feather River basin as a migratory corridor and the presence of spawning and rearing habitat in the watershed make it an important area for the survival and recovery of the species.

Lindley *et al.* (2007) indicated that prior population census estimates completed in the 1990s found the CCV steelhead spawning population above the Red Bluff Diversion Dam had a fairly strong negative population growth rate and small population size. Good *et al.* (2005) indicated the decline was continuing as evidenced by new information. CCV steelhead populations generally show a continuing decline, an overall low abundance, and fluctuating return rates. Although there is limited data concerning the status of CCV steelhead, Lindley *et al.* (2007) concluded that there is sufficient evidence to suggest that the DPS is at moderate to high risk of extinction.

2.7.1.3. Southern DPS North American green sturgeon

The viability of sDPS green sturgeon is constrained by factors, such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. The risk of extinction is believed to be moderate because, although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2010).

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

The principal threat to green sturgeon in the sDPS is the reduction of available spawning habitat, due to the construction of barriers on Central Valley rivers. Other threats are insufficient flow rates, increased water temperatures, water diversion, non-native species, poaching, pesticide and heavy metal contamination, and harvest (71 FR 17757). There is a strong need for additional information about sDPS green sturgeon, especially with regards to a robust abundance estimate, a greater understanding of their biology, and further information about their micro- and macro-habitat ecology.

2.7.2. Summary of Effects of the Proposed Action of Listed Species and Critical Habitat

Sediment dredging would occur during the summertime (June 15 to October 15) when ESA-listed salmonids and sDPS green sturgeon are least likely to be present in the Action Area. The in-water work window may be extended to November 30 if it is determined that the dredging proposed for both Phase 1 and Phase 2 can be completed in a single dredging season. Disturbance resulting from dredging activities would be short-term (*e.g.*, 12 hours per day), during daylight hours to the maximum extent practicable (nighttime work may be required to complete the Project in a single season). At any given time, the disturbance would be confined to a small footprint around the area being dredged, leaving the majority of the channel unaffected or minimally affected by dredging activities. Furthermore, the presence of the turbidity curtain around the dredging area coupled with noise and activity associated with the dredging activity would likely cause these fish to avoid the immediate area by moving downstream a safe distance away from the area being dredged or by holding upstream until dredging is completed each day.

Substrate material in the lower Feather and Yuba rivers within the Action Area is comprised largely of fine sediments. Removal of accumulated sediments has the potential to disturb the substrate material, thereby creating a plume of elevated sediments, increased turbidity levels, and increased concentrations of sediment-bound pollutants in the water column in the immediate vicinity and downstream of the dredged area. The physiology of fish exposed to elevated suspended sediment loads or turbidity may be adversely affected through such physical mechanisms as gill trauma, alteration of osmoregulation, alteration of blood sugar levels, and behavioral responses (*e.g.*, avoidance, decreased foraging success) (Bash *et al.* 2001).

Dewatering operations in tanks or basins and the return of decanted water back to the Feather or Yuba rivers, could also adversely affect surface water quality in the Feather and Yuba rivers. The decanted return water is expected to have lower turbidity and concentrations of any pollutants than the Feather or Yuba rivers. However, sediments may become suspended, causing a localized increase in turbidity around the point(s) of discharge into these rivers.

As noted in the Effects of the Proposed Action section above, analyses of sediment grab samples collected in April 2020, in the proposed dredging area detected the presence of barium (42-60 mg/kg total), chromium (17-22 mg/kg total), cobalt (6.6-7.7 mg/kg total), copper (6.3-7.3 mg/kg), nickel (31-41 mg/kg total), vanadium (19-21 mg/kg total), and zinc (15-18 mg/kg total) in concentrations below federal and State criteria for hazardous waste and below screening levels for impacts on aquatic life. All other total petroleum hydrocarbons, semi-volatile organic compounds, organochlorine pesticides, and metals were non-detectable in these samples. As such, resuspension of sediments during dredging is not anticipated to create a plume of pollutants in concentrations that would be hazardous to ESA-listed fishes moving through the lower Feather or Yuba rivers in the Action Area. Furthermore, all equipment refueling and maintenance would occur in an upland area at a sufficient distance to preclude any construction-related hazardous materials from entering the Feather or Yuba rivers and refueling in the upland portion of the Action Area will use appropriate secondary containment techniques to prevent spills.

2.7.2.1. Central Valley spring-run Chinook salmon and California Central Valley steelhead

Both CV spring-run Chinook and CCV steelhead have a very low probability of being present due to the proposed timing for in-water work. Given the relatively small volume of sediment expected to be re-suspended during cutterhead dredging, the plume is anticipated to be confined to within approximately 100 feet downstream of the dredging activity, while the plume resulting from mechanical dredging may extend further downstream (*e.g.*, 500 feet). In both cases, the plume of elevated suspended sediments will be minimized, to the extent feasible, by the use of a turbidity curtain and will likely settle out to background turbidity and suspended sediment concentrations within a short period (*i.e.*, hours). As such, any ESA-listed anadromous fishes passing through the lower Feather or Yuba rivers would be able to effectively avoid the plume immediately downstream of the dredging activity and, therefore, their migrations are not expected to be blocked or substantially delayed.

Based on the timing of the proposed dredging actions (June 15 through October 15), NMFS expects the majority of the impacts created by dredging activities to be experienced by early-arriving adult CCV steelhead migrating upstream to the Feather and Yuba rivers during the latter portion of the dredging season. In the event that the in-water work window is extended to November 30, in order to allow both Phase 1 and Phase 2 to be completed in a single dredging season, the number of early-arriving adult CCV steelhead migrating through the Action Area that are likely to be exposed to the dredging activities may increase slightly. However, to minimize impacts associated with in-water work from the period of October 15-November 30, work would only occur during daylight hours to ensure that migrating adults have an opportunity to move upstream through the Action Area unimpeded during nighttime hours. We do not expect that the extension of the in-water work window to November 30 to adversely affect CV spring-run Chinook salmon adults or juveniles, or CCV steelhead juveniles, as their presence is not expected to increase in the Action Area during the period from October 15-November 30.

Additionally, some adult spring-run Chinook salmon could migrate through the Action Area during the initial portion of the dredging season in June. However, the majority are expected to have reached holding and spawning habitat upstream within the LFC of the Feather River or in the Yuba River, prior to the beginning of the dredging activities. In the event that migrating adults are present during the proposed in-water work window, they are expected to move through the deeper portion of the channel away from dredging activity and outside the turbidity curtain.

Therefore, any adult immigrating salmonids would likely avoid exposure to adverse Project-related increases in turbidity.

It is expected that a small number of spring-run Chinook salmon and steelhead smolts may be migrating downstream during the proposed in-water work window. However, their numbers are expected to be low compared to the peak of migration in the spring, and tend to be associated with rain events or pulse flow operations on the tributaries. Increased flows in the main channel of the Feather River resulting from pulse flows or winter precipitation would be expected to ameliorate the negative effects of the dredging action by shortening the duration of migration through the Action Area and diluting the re-suspended sediments in the water column. For those fish that do not or cannot avoid the turbid water, exposure is expected to be brief (*i.e.*, minutes to hours) and not likely to cause injury or death from reduced growth, or physiological stress. However, some juveniles that are exposed to areas of temporarily elevated turbidity may be injured or killed by predatory fish that take advantage of disrupted normal behavior.

The Project site is used as a migration corridor for CV spring-run Chinook salmon and CCV steelhead, but the timing of the proposed action is outside of the peak of their migration timing. Adult CV spring-run Chinook salmon and CCV steelhead that may encounter the hydraulic dredge would likewise be able to avoid and escape entrainment due to their greater swimming speed. However, there is a low possibility that out-migrating or rearing juveniles could be present during dredging and may become entrained or injured by the dredging equipment. Therefore, small numbers of juvenile spring-run Chinook salmon and/or CCV steelhead present in the Action Area during the proposed dredging activities would be killed, harmed or harassed by coming into direct contact with the dredge or by being displaced, resulting in reduced feeding, and increased predation.

The majority of the CV spring-run Chinook salmon population emigrating through the Delta and San Francisco estuary originate in the Sacramento River basin. Only a small fraction of these fish would be affected by the Project. Annual losses of juvenile CV spring-run Chinook salmon related to the Project's dredging impacts would be a small proportion of the entire ESU. Thus, the amount of loss associated with the Project should not have a demonstrable impact on the abundance of juvenile CV spring-run Chinook salmon out-migrating from the ESU. Likewise, the very small numbers of adult fish that may be lost to dredging effects would not noticeably alter the abundance or productivity of the ESU. However, the Project does not improve the status of the ESU's abundance or productivity or chances of recovery either. Likewise, the Project does not improve the status of the spatial structure or diversity of the ESU.

Similar to the CV spring-run Chinook salmon ESU, the majority of the CCV steelhead DPS migrating through the Delta and San Francisco estuary originates in the Sacramento River basin. Only a small fraction of these fish would be affected by the Project. The cumulative annual loss of juvenile steelhead resulting from the proposed Project would be small compared to the number of juvenile CCV steelhead within the entire DPS that migrate through the Delta annually. Thus, the amount of loss associated with the Project should not have a demonstrable impact on the abundance of juvenile CCV steelhead out-migrating from the DPS. Likewise, the very small numbers of adult fish that may be lost to dredging effects would not noticeably alter the abundance or productivity of the DPS. However, while annual losses are small, the Project does not improve the status of the DPS's abundance or productivity either. Likewise, the Project does not improve the status of the spatial structure or diversity of the DPS.

In summary, when added together with the status of the species, the environmental baseline, the cumulative effects, and the effects of the proposed action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of CV spring-run Chinook salmon or CCV steelhead in the wild by reducing their numbers, reproduction, or distribution.

2.7.2.2. Southern DPS North American green sturgeon

Adult green sturgeon move into estuaries and lower reaches of rivers to feed between mid-February and early May and spawning occurs from April through early July (NMFS 2010). NMFS expects that a large proportion, if not all of the adult green sturgeon, will have migrated upstream past the Action Area to spawning habitats in the Feather and Yuba rivers, prior to the proposed in-water work window. However, given the variability in adult sDPS green sturgeon migration timing (both upstream and downstream migrations), it is possible that a very small number of adult sDPS green sturgeon may be exposed to the proposed dredging operations.

During years when successful spawning occurs in the upper reaches of the Feather and/or Yuba rivers, it is expected that juvenile green sturgeon may be present in the Action Area during dredging activities and may be exposed to increased levels of turbidity. While there is no specific information available to evaluate the potential responses of sDPS green sturgeon to increased turbidity and suspended sediment, it is possible that higher concentrations of suspended sediment and turbidity may interfere with normal feeding and migratory behavior. Additionally, the small number of juvenile green sturgeon expected to occur in the Action Area during their downstream migration to the Delta may be entrained, injured, or killed if they come into close contact with the cutterhead suction intake. However, the number of fish moving downstream through the Action Area during the proposed dredging period is expected to be low. Juvenile green sturgeon migrating downstream would be expected to remain the deeper portions of the channel, at a safe distance from the active dredging operations. Furthermore, the presence of the turbidity curtain, coupled with construction noise associated with the dredging, would likely cause these fish to avoid the immediate dredging area and the plume of elevated turbidity extending downstream. If it is determined that Phase 1 and Phase 2 can be completed in a single dredging season, we do not expect the extension of the in-water work window to November 30 to adversely affect sDPS green sturgeon, as their presence in the Action Area is not expected to change or increase during the period from October 15-November 30.

The overall cumulative annual loss of individual sDPS green sturgeon due to the Project would be small, and represents a minor fraction of the entire population of sDPS green sturgeon present in the Feather and Yuba rivers, which includes juveniles, sub-adults and adults. However, while the cumulative numbers of fish lost may be small compared to the entire population, the Project represents a chronic, yet very small negative strain on the DPS's viability. In summary, the small numbers of fish lost annually from the sDPS green sturgeon population due to the effects of the Project would not substantially reduce the viability of the entire DPS. Therefore, when added together with the status of the species, the environmental baseline, the cumulative effects, and the effects of the proposed action, the Project is not likely to reduce appreciably the likelihood of both the survival and recovery of sDPS green sturgeon in the wild by reducing its numbers, reproduction, or distribution.

2.7.2.3. Designated Critical Habitat

The proposed project is likely to result in localized and temporary adverse effects to the designated critical habitat for each of the species considered above. The proposed dredging will periodically contribute to the elevated suspended sediment, noise, and contaminant levels in the Action Area. These effects would be short-term, infrequent, and minimized implementing the proposed AMMs.

Long-term habitat changes will occur in the lower Feather River, extending from just upstream to just downstream of the Yuba River confluence, as a result of the proposed Project. The portion of the lower Feather River within the Action Area serves as a seasonal (*i.e.*, primarily fall-winter) migratory corridor for ESA-listed anadromous salmonids and sDPS green sturgeon. The PBFs of critical habitat for CV spring-run Chinook salmon and CCV steelhead include freshwater migration and freshwater rearing, while PBFs of critical habitat for sDPS green sturgeon include food resources, water flow, water quality, migratory corridor depth, and sediment quality.

Dredging activities associated with the proposed action will only affect in-water habitat and will not disturb riparian habitats. The most important habitat attribute of the riverbed to listed anadromous fish species in the Action Area is the production of food items for rearing and migrating juveniles. The loss of benthic food resources, such as amphipods or isopods, could reduce fish growth rates and increase the energy expended searching for food, depending on the density of the animal assemblages on the channel bottom. This would be more likely to occur to sturgeon, which are specialized benthic feeders, but also may affect juvenile CV spring-run Chinook salmon and CCV steelhead, although to a lesser degree. However, outmigrating CV spring-run Chinook salmon, CCV steelhead, and rearing sDPS green sturgeon should be able to find alternative foods and foraging areas outside of the project footprint. Overall, the proposed dredging is not likely to change the benthic habitat to the extent that ESA-listed species would be negatively affected in the reaches to be dredged.

The long-term effects on habitat for ESA-listed anadromous fishes in the lower Feather River are limited to a localized reduction of accumulated sediment immediately upstream and downstream of the Yuba River confluence. This will result in an incremental and localized improvement in migration conditions for ESA-listed fishes by returning the Feather River channel to a more natural condition, and reducing the overall fine sediment load. For these reasons, the long-term effects to the PBFs of designated critical habitat are expected to be beneficial.

2.7.2.4. Summary

The combined effects of the proposed action will have mixed consequences on ESA-listed fish in the Action Area. Exposure to the direct and indirect effects of the proposed action will likely increase the extent of mortality related to predation, exposure to degraded water quality conditions, and potential delays in migration to the ocean, experienced by listed species. These effects are expected to occur primarily during the 5 months of the year when dredging operations will be occurring (June 15 through October 15). The remaining 7 months of the year will see only residual effects associated with habitat alterations incurred during those previous dredging operations (*e.g*., changes in macroinvertebrate density and populations, extent of exposure to temporarily elevated concentrations of suspended sediment, *etc*.).

Although construction is expected to cause adverse effects to small numbers of ESA-listed fish, the impacts will be relatively short in duration and will avoid higher river and peak migration time periods, so that abundance would be low within the project footprint. Additionally, most of the effects are not expected to be lethal. Dredging-related harassment will be temporary and will not impede adult fish from reaching upstream spawning and holding habitat, or juvenile fish from migrating downstream. While potential adverse effects are expected to be temporary, the proposed action is expected to improve the quality and function of the Action Area as a migratory corridor for ESA-listed species by returning the Feather River channel to a more natural condition (*e.g*., prior to the Oroville Dam Spillway Incident), and reducing the overall fine sediment load.

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 cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon 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). "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS. The take exemption conferred by this incidental take statement is based upon the proposed action occurring as described in the biological opinion and in more detail in the BA for the Project (ECORP Consulting, Inc. 2020).

2.9.1. Amount or Extent of Take

In the biological opinion, NMFS determined that incidental take is reasonably certain to occur as follows:

Take in the form of harm, harassment, or mortality of adult and juvenile CV spring-run Chinook salmon, adult and juvenile CCV steelhead, and adult and juvenile sDPS green sturgeon as a result of exposure to the direct and indirect effects of the proposed dredging activities at the Yuba City Boat Ramp.

Some of the harm associated with this exposure is expected to result from entrainment in the dredging equipment, harassment from the generation of turbidity resulting from the resuspension of sediments, increased vulnerability to predation, and reduced prey availability in the Action Area. Exposure to the adverse effects associated with dredging operations in the Action Area is limited to the 5-month operational period from June 15 through October 15.

NMFS cannot, using the best available information, accurately quantify the anticipated incidental take of individual listed fish because of the variability and uncertainty associated with the population size of each species, annual variations in the timing of migration, and uncertainties regarding individual habitat use within the Action Area. However, it is possible to estimate the extent of incidental take by designating ecological surrogates, and it is practical to quantify and monitor the surrogates to determine the extent of incidental take that is occurring. Overall, the number of ESA-listed fish that may be incidentally taken during the proposed dredging activities is expected to be small, due to the proposed AMMs, such as adhering to the in-water work window, when ESA-listed species are least likely to be present.

The most appropriate ecological surrogate for providing a quantifiable metric for determining the extent of incidental take of ESA-listed fish caused by the proposed dredging operations is amount of dredged sediment removed (CYs), the extent of the area to be dredged (acres), and the downstream extent of the Action Area impacted by increased turbidity. The area impacted from the proposed dredging operation can be consistently and accurately measured during Project implementation and, therefore, serves as a physically measurable proxy for the incidental take of listed fish.

Ecological Surrogate:

Approximately 315,600 CY of dredged material would be removed within an approximately 28-acre area and may occur over two phases. Phase 1 includes the removal of approximately 65,600 CY of dredged material within an approximate 14.41-acre Dredging Area. Phase 2 includes an additional approximately 250,000 CY of dredged material within an approximate 14.40-acre Future Dredging Area immediately downstream of the Phase 1 Dredging Area.

The analysis of the effects of the proposed dredging project would result in temporary increases to the ambient background levels of turbidity in the aquatic environment within and downstream from the areas to be dredged. Based on the methods described for performing dredging operations, the types of equipment that would be employed to carry out those activities, and the effects analysis conducted for this consultation, the observed increases in turbidity above ambient background conditions in the aquatic environment would extend approximately 500 feet downstream from the specific locations where active dredging operations are being conducted.

Therefore, incidental take will be exceeded if the following occurs:

1. The amount of dredged sediment exceeds 315,600 CY over the two Phases,

2. The area dredged exceeds more than 30 acres (for Phase 1 and Phase 2 combined), or
3. Turbidity increases resulting from dredging activities extends beyond 500 feet downstream of the area being dredged.

If the limits to the extent of incidental take represented by the ecological surrogate are exceeded, the proposed Project will be considered to have exceeded anticipated take levels, triggering the need to reinitiate consultation.

2.9.2. Effect of the Take

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

1. The Corps and the SBFCA will avoid or minimize impacts to ESA- listed species associated with the implementation of the proposed dredging Project.
2. The Corps and the SBFCA will monitor and report on the amount or extent of incidental take (see ecological surrogate above).

2.9.4. Terms and Conditions

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

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

    a. As described in the Water Quality Plan for the Project (Attachment F in the BA), on all days of in-water work activities, grab samples will be collected prior to commencement of in-water work to establish a baseline, every four hours during in-water work, and upon completion of in-water work for the day. Measurements of turbidity (NTU), dissolved oxygen (DO), pH, and water temperature will be made using a handheld multi-parameter water quality meter (e.g., Horiba U-50). These measurements will be made by staff trained in the proper use and maintenance of the instrument. Monitoring of turbidity levels of the waters where the dredge is operating will be conducted to verify that water quality criteria are not exceeded, as described in the description of ecological surrogates, above. If levels are exceeded, NMFS will be notified and work halted until corrective actions are instituted to achieve surface water quality criteria.

b. For the approximate 14.40-acre Phase 2 Dredging Area, the Corps shall provide a depiction of the existing depths of the rivers, the proposed dredging depth, and the proposed post-dredging depths to NMFS, prior to commencing Phase 2 construction activities to ensure that those levels are consistent with the levels identified in the ITS above.

c. Equipment used for the Project should be thoroughly inspected off-site for drips or leaks.

d. Equipment used for the Project should be thoroughly cleaned off-site to prevent introduction of contaminants.

e. Any lights used in or around the water at night during the in-water work window of June 15-October 15 should be shielded to ensure that only the necessary light is being directed into the water.

f. In the event that dredging operations for both Phase 1 and Phase 2 are anticipated to be completed in a single year, the in-water work window may be extended from October 15-November 30. During the period from October 15-November 30, in-water work will only occur during daylight hours to allow for a period of unimpeded passage through the Action Area during nighttime hours.

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

a. The required annual report shall be provided by December 31 following the dredging season and will include at a minimum:

   i. Specific timing of dredging operations each year (within the proposed in-water work window of June 15–October 15).
   ii. The amount of dredged sediment removed in CY
   iii. The extent of the dredged area in acres

Reports should be sent to the following email address while staff are situated remotely, or to the physical mailing address, after staff return to the office:

Assistant Regional Administrator
National Marine Fisheries Service
California Central Valley Office
650 Capitol Mall, Suite 5-100
Sacramento, California 95814-4706
ccvo.consultationrequests@noaa.gov

b. The Corps or the SBFCA will visually monitor the waterway adjacent to the area being dredged (*i.e.*, within 500 feet) during all dredging operations for any affected fish, including, but not limited to CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon.

Observation of affected fish will be reported to NMFS by telephone at (916) 930-3600, by FAX at (916) 930-3629, or at the email address given above within 24 hours of the incident. Dredging operations will be halted immediately until the Corps coordinates with NMFS to determine the cause of the incident and whether any additional protective measures are necessary to protect ESA-listed salmonids and green sturgeon. Any protective measures that are determined necessary to protect listed salmonids and sturgeon will be implemented as soon as practicable within 72 hours of the incident. Affected fish are defined as:

- Dead or moribund fish at the water surface;
- Showing signs of erratic swimming behavior or other obvious signs of distress;
- Gasping at the water surface; or
- Showing signs of other unusual behavior.

A follow-up written notification will also be submitted to NMFS, which includes the date, time, and location that the carcass or injured specimen was found, a color photograph, the cause of injury or death, if known, and the name and affiliation of the person who found the specimen. Written notification will be submitted to NMFS at the above address. Any dead specimen(s) will be placed in a cooler with ice and held for pick up by NMFS personnel or an individual designated by NMFS to do so.

2.10. Conservation Recommendations

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

1. The Corps should continue to work cooperatively with other State and Federal agencies, private landowners, governments, and local watershed groups to identify opportunities for cooperative analysis and funding to support recovery actions in the NMFS Salmonid Recovery Plan (NMFS 2014) and the NMFS Recovery Plan for the Southern DPS of North American Green Sturgeon (NMFS 2018).
2. To the extent practicable, equipment should be serviced with petroleum or other containment sources, off-site.

2.11. Reinitiation of Consultation

This concludes formal consultation for the Yuba City Boat Ramp Sediment Removal Project.

As 50 CFR 402.16 states, 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 if: (1) The amount or extent of incidental taking specified in the ITS is exceeded, (2) new information reveals effects of the agency action that may affect listed species or critical habitat in a manner or to an extent not considered in this opinion, (3) the 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 (4) a new species is listed or critical habitat designated that may be affected by the action.

3. Magnuson-Stevens Fishery Conservation and Management Act Essential Fish Habitat 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 direct or indirect physical, chemical, or biological alteration of the waters or substrate and loss of (or injury to) benthic organisms, prey species and their habitat, and other ecosystem components, if such modifications reduce the quality or quantity of EFH. Adverse effects on EFH may result from actions occurring within EFH or outside of it and may include site-specific or EFH-wide impacts, including individual, cumulative, or synergistic consequences of actions (50 CFR 600.810). Section 305(b) 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 Corps 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

The PFMC has identified and described EFH, Adverse Impacts and Recommended Conservation Measures for salmon in Amendment 14 to the Pacific Coast Salmon FMP (PFMC 1999). The proposed Project site is within the region identified as EFH for Pacific Coast salmon in Amendment 14 of the Pacific Coast Salmon FMP. Freshwater EFH for Pacific Coast salmon in the Central Valley includes waters currently or historically accessible to salmon within the Central Valley ecosystem as described in Myers *et al.* (1998), and includes the Feather and Yuba rivers. Central Valley spring-run Chinook salmon (*O. tshawytscha*) and Central Valley fall-/late fall-run Chinook salmon (*O. tshawytscha*) are species managed under the Pacific Coast Salmon FMP that occur in the Action Area.

- Habitat Areas of Particular Concern (HAPCs) for Pacific Coast Salmon are: complex channel and floodplain habitat, spawning habitat, thermal refugia, estuaries, and submerged aquatic vegetation (see descriptions of salmon HAPCs in Appendix A to the Pacific Coast Salmon FMP, pcouncil.org).

The Corps has determined that the proposed Project may adversely affect EFH for federally managed fish species within the Pacific Coast Salmon FMP. The HAPCs present in the Action Area that may be adversely affected by the proposed Project is complex channels and floodplain habitats.

3.2. Adverse Effects on Essential Fish Habitat

The potential effects of the proposed action on EFH for Pacific Coast salmon include short-term effects associated with dredging activities. The lower Feather River within the Action Area primarily serves as a migration corridor for Chinook salmon migrating to/from spawning and rearing habitats in the upper reaches of the Feather and Yuba rivers.

In the short-term, the proposed Project would adversely affect EFH through the re-suspension of sediments potentially resulting in temporary (1) increases in turbidity, (2) reductions of prey availability, and (3) increased levels of re-suspended contaminants. The effects of the proposed action on CV spring-run Chinook salmon and CCV steelhead habitat are described in detail in the preceding biological opinion, and generally are expected to apply to EFH for Pacific Coast salmon. Adverse effects to designated critical habitat for ESA-listed species and EFH HAPCs are appreciably similar; therefore, no additional discussion is included. Listed below are the adverse effects on EFH reasonably certain to occur:

1. Increased turbidity and suspended sediment
2. Reduction in aquatic macroinvertebrate production
3. Degraded water quality

The long-term effects to EFH for Pacific Coast salmon in the lower Feather River are limited to a localized reduction of accumulated sediment immediately upstream and downstream of the Yuba River confluence. This will result in an incremental and localized improvement in migration conditions for Chinook salmon by returning the Feather River channel to a more natural condition, and reducing the overall fine sediment load. For these reasons, the long-term habitat effects of the proposed action are expected to be beneficial.

3.3. Essential Fish Habitat Conservation Recommendations

NMFS determined that the following conservation recommendations are necessary to avoid, minimize, mitigate, or otherwise offset the impact of the proposed action on EFH.

1. Measures should be taken to maintain, monitor, and adaptively manage all conservation measures throughout the life of the proposed program to ensure their effectiveness.

2. Measures should be taken to ensure that contractors, construction workers, and all other parties involved with this program implement the program as proposed in the biological assessment and this biological opinion.

Fully implementing these EFH conservation recommendations would protect, by avoiding or minimizing the adverse effects described in section 3.2, above, for Pacific Coast salmon.

3.4. Statutory Response Requirements

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

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

3.5. Supplemental Consultation

The Corps 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 user of this opinion is the U.S. Army Corps of Engineers. Other interested users could include the Sutter-Butte Flood Control Agency and ECORP Consulting, Inc. Individual copies of this opinion were provided to the Corps. The document will be available within two weeks at the NOAA Library Institutional Repository [https://repository.library.noaa.gov/welcome]. The format and naming adheres to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

5. REFERENCES

63 FR 13347. March 10, 1998. Endangered and Threatened Species: Threatened Status for Two ESUs of Steelhead in Washington, Oregon, and California. Final rule; notice of determination. 25 pages. Office of the Federal Register.

64 FR 50394. September 16, 1999. Endangered and Threatened Species; Threatened Status for Two Chinook Salmon Evolutionarily Significant Units (ESUs) in California. 22 pages. Office of the Federal Register.

70 FR 37160. June 28, 2005. Final Listing Determinations for 16 ESUs of West Coast Salmon, and Final 4(d) Protective Regulations for Threatened Salmonid ESUs. 46 pages. Office of the Federal Register.

70 FR 52488. September 2, 2005. Designation of Critical Habitat for Seven Evolutionarily Significant Units of Pacific Salmon and Steelhead in California; Final Rule. 141 pages. Office of the Federal Register.

71 FR 834. January 5, 2006. Endangered and Threatened Species: Final Listing Determinations for 10 Distinct Population Segments of West Coast Steelhead. Final Rule. 30 pages. Office of the Federal Register.

71 FR 17757. April 7, 2006. Threatened Status for Southern Distinct Population Segment of North American Green Sturgeon. 10 pages. Office of the Federal Register.

74 FR 52300. October 9, 2009. Final Rulemaking to Designate Critical Habitat for the Threatened Southern Distinct Population Segment of North American Green Sturgeon. 53 pages. Office of the Federal Register.

84 FR 44977. August 27, 2019. Endangered and Threatened Wildlife and Plants; Regulations for Interagency Cooperation; Final Rule. 43 pages. Office of the Federal Register.

Allen, K. O., and J. W. Hardy. 1980. Impacts of Navigational Dredging on Fish and Wildlife: A Literature Review. Pages 1-100 in U.S. Department of the Interior, editor, Fish and Wildlife Service.

Arkoosh MR, Clemons E, Myers M, Casillas E. Suppression of B-cell mediated immunity in juvenile Chinook salmon (*Oncorhynchus tshawytscha*) after exposure to either a polycyclic aromatic hydrocarbon or to polychlorinated biphenyls. Immunopharmacol Immunotoxicol. 1994 May; 16(2):293-314. DOI: 10.3109/08923979409007096. PMID: 8077612.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of turbidity and suspended solids on salmonids. Center for Streamside Studies, University of Washington, Seattle, WA. 66 pp.

Berg, L. and Northcote, T.G. 1985. Changes in territorial gill-flaring and feeding behavior in juvenile Coho salmon (*Oncorhynchus kisutch*) following short-term pulses of suspended sediment. Canadian Journal of Fisheries and Aquatic Sciences 42:1410-1417.

Bisson, P. A., and R. E. Bilby. 1982. Avoidance of suspended sediment by juvenile Coho salmon. North American Journal of Fisheries Management. 2(4): 371-374.

Buer, K., D. Forwalter, B. Ross, T. Bouillion, J. Mulder, and G. Gordon. 2004. Effects of Project Operations on Geomorphic Processes Downstream of Oroville Dam: Task 1.2 - Physiographic Setting and Mesohabitat.

Busby, P. J., T. C. Wainwright, G. J. Bryant, L. J. Lierheimer, R. S. Waples, W. Waknitz, and I. Lagomarsino. 1996. Status Review of West Coast Steelhead from Washington, Idaho, Oregon and California.

California Department of Fish and Game (CDFG). 1991. The Lower Yuba River Fisheries Management Plan. Final Report. The Resources Agency, CDFG, Stream Evaluation Report No. 91-1. February.

California Department of Fish and Wildlife. 2018. 2018 Yuba River Sturgeon Spawning Study. Memorandum from Marc Beccio to Colin Purdy. July 11, 2018.

California Department of Fish and Wildlife. 2018b. GrandTab Spreadsheet Chinook Salmon Escapement in the Central Valley.

California Department of Fish and Wildlife. 2019. 2019 Yuba River Sturgeon Spawning Study. Memorandum from Marc Beccio to Morgan Kilgour. November 18, 2019.

California Department of Water Resources. 2007. Biological Assessment for Federally Listed Anadromous Fishes (FERC Project-2100). Page 446.

California Fish Tracking Database. 2015. Available from: http://californiafishtracking.ucdavis.edu/default.shtml

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

Cramer Fish Sciences. 2011. Memo: Green Sturgeon Observations at Daguerre Point Dam, Yuba River, CA.

Daughton, C.G. 2003. Cradle-to-cradle stewardship of drugs for minimizing their environmental disposition while promoting human health. I. Rationale for and avenue toward a green pharmacy. Environmental Health Perspectives 111:757-774.

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

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

Emmett, R.L., S.A. Hinton, S. L. Stone, and M.E. Monaco. 1991. Distribution and abundance of fishes and invertebrates in west coast estuaries. In: Species life history summaries, vol.2. ELMR Report No. 8. NOAA/NOS Strategic Environmental Assessments Division, Rockville MD.

Ewing, R. 1999. Diminishing Returns: Salmon Decline and Pesticides. Oregon Pesticide Education Network.

Federal Energy Regulatory Commission (FERC). 2007. Final Environmental Impact Statement for Hydropower License - Oroville Facilities (FERC Project No. 2100-052).

Good, T. P., R. S. Waples, and P. Adams. 2005. Updated Status of Federally Listed ESUs of West Coast Salmon and Steelhead. NOAA Technical Memorandum NMFS-NWFSC-66.

Gregory, R. S., and C. D. Levings. 1998. Turbidity reduces predation on migrating juvenile Pacific salmon. Transactions of the American Fisheries Society 127: 275-285.

Gregory, R. S., and T. G. Northcote. 1993. Surface, planktonic, and benthic foraging by juvenile chi-nook salmon (*Oncorhynchus tshawytscha*) in turbid laboratory conditions. Canadian Journal of Fisheries and Aquatic Sciences 50: 233–240.

Heublein, J. C., J. T. Kelly, C. E. Crocker, A. P. Klimley, and S. T. Lindley. 2008. Migration of green sturgeon, *Acipenser medirostris*, in the Sacramento River. Environmental Biology of Fishes Online first, DOI 10.10078/s10641-008-9432-9.

Kynard, B., and M. Horgan. 2001. Guidance of yearling shortnose and pallid sturgeon using vertical bar rack and louver arrays. North American Journal of Fisheries Management 21(3):561-570.

Lindley, S. T., R. S. Schick, A. Agrawal, M. Goslin, T. E. Pearson, E. Mora, J. J. Anderson, B. May, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2006. Historical Population Structure of Central Valley Steelhead and its Alteration by Dams. San Francisco Estuary and Watershed Science 4:19.

Lindley, S. T., R. S. Schick, B. P. May, J. J. Anderson, S. Greene, C. Hanson, A. Low, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2004. Population Structure of Threatened and Endangered Chinook Salmon ESUs in California's Central Valley Basin.*in* U.S. Department of Commerce, editor.

Lindley, S. T., R. S. Schick, E. Mora, P. B. Adams, J. J. Anderson, S. Greene, C. Hanson, B. P. May, D. McEwan, R. B. MacFarlane, C. Swanson, and J. G. Williams. 2007. Framework for Assessing Viability of Threatened and Endangered Chinook Salmon and Steelhead in the Sacramento-San Joaquin Basin. San Francisco Estuary and Watershed Science 5:28.

McEwan, D., and T. A. Jackson. 1996. Steelhead Restoration and Management Plan for California.

Moore, A., and C. P. Waring. 1996. Sublethal effects of the pesticide Diazinon on olfactory function in mature male Atlantic salmon parr. Journal of Fish Biology 48(4):758-775.

Mora, E. A., S. T. Lindley, D. L. Erickson, and A. P. Klimley. 2009. Do Impassable Dams and Flow Regulation Constrain the Distribution of Green Sturgeon in the Sacramento River,

Moyle, P. B. 2002. Inland Fishes of California. University of California Press, Berkeley and Los Angeles.

National Marine Fisheries Service. 2010 Federal Recovery Outline North American Green Sturgeon Southern Distinct Population Segment Page 23.

National Marine Fisheries Service. 2014. Final Recovery Plan for the Evolutionarily Significant Units of Sacramento River Winter-run Chinook Salmon and Centrall Valley Spring-run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead. Page 427. NMFS, Sacramento, CA.

National Marine Fisheries Service. 2015. 5-Year Summary and Evaluation: Southern Distinct Population Segment of the North American Green Sturgeon Page 42. U.S. Department of Commerce,, Long Beach, CA

National Marine Fisheries Service. 2016a. 5-Year Review: Summary and Evaluation of Central Valley Spring-run Chinook Salmon ESU (2016). Page 41. West Coast Region.

National Marine Fisheries Service. 2016b. 5-Year Review: Summary and Evaluation of California Central Valley Steelhead Distinct Population Segment. Page 44. NMFS, Sacramento, CA.

National Marine Fisheries Service. 2018. Recovery Plan for the Southern Distinct Population Segment of North American Green Sturgeon (Acipenser medirostris). Pages 95 *in* National Marine Fisheries Service, editor.

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

Poytress, W.R., J. J. Gruber, and J. Van Eenennaam. 2010. 2009 Upper Sacramento River Green Sturgeon Spawning Habitat and Larval Migration Surveys. Annual Report of U.S. Fish and Wildlife Service to U.S. Bureau of Reclamation, Red Bluff, CA.

Poytress W.R., J.J. Gruber, and J.P. Van Eenennaam. 2011. 2010 Upper Sacramento River Green Sturgeon Spawning Habitat and Larval Migration Surveys. Annual Report of U.S. Fish and Wildlife Service to U.S. Bureau of Reclamation, Red Bluff, CA.

Radtke, L. D. 1966. Ecological Studies of the Sacramento-San Joaquin Delta. Part II: Fishes of the Delta: Distribution of Smelt, Juvenile Sturgeon, and Starry Flounder in the Sacramento-San Joaquin Delta with Observations on Food of Sturgeon. Fish Bulletin 136:115-129.

Rand, G. M. 1995. Fundamentals of Aquatic Toxicology: Effects, Environmental Fate, and Risk Assessment, Second edition. Taylor & Francis, Washington, DC.

Reynolds, F. L., R. L. Reavis, and J. Schuler. 1990. Central Valley Salmon and Steelhead Restoration and Enhancement. Sacramento, CA: California Department of Fish and Game.

Reine, K., and D. Clark. 1998. Entrainment by hydraulic dredges - A review of potential impacts. Technical Note DOER-E1. U.S. Army Corps of Engineer Research and Development Center, Vicksburg, Missouri.

Scholz, N. L., and coauthors. 2000. Diazinon disrupts antipredator and homing behaviors in Chinook salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 57(9):1911-1918.

Seesholtz, A., B. Cavallo, R. Kurth, and J. Kindopp. 2004. Juvenile Fishes of the Lower Feather River: Distribution, Emigration Patterns, and Associations with Environmental Variables. American Fisheries Society Symposium 39: 141 -166.

Seesholtz, A. M., M. J. Manuel, and J. P. Van Eenennaam. 2015. First Documented Spawning and Associated Habitat Conditions for Green Sturgeon in the Feather River, California. Environmental Biology of Fishes 98:905-912.

Servizi, J. A., and D. W. Martens. 1992. Sublethal Responses of Coho salmon (*Oncorhynchus kisutch*) to Suspended Sediments. Canadian Journal of Fisheries and Aquatic Sciences 49: 1389–1395.

Sigler, J. W., T. C. Bjornn, and F. H. Everest. 1984. Effects of chronic turbidity on density and growth of steelheads and Coho salmon. Transactions of the American Fisheries Society 113:142-150.

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

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

Van Eenennaam, J.P., Linares-Casenave, J., Deng, X., and Doroshov, S.I. 2005. Effect of incubation temperature on green sturgeon embryos, *Acipenser medirostris*. Environmental Biology of Fishes 72(2): 145-154.

Van Eenennaam J.P., J. Linares, S.I. Doroshov, D.C. Hillemeier, T.E. Wilson, and A.A. Nova. 2006. Reproductive conditions of the Klamath River green sturgeon. Trans. Am. Fish. Soc. 135(1): 151-163.

Waring, C. P., and A. Moore. 1997. Sublethal Effects of a Carbamate Pesticide on Pheromonal Mediated Endocrine Function in Mature Male Atlantic Salmon (Salmo salar L.) Parr. Fish Physiology and Biochemistry 17(1-6):203-211.

White, J. S. S., K. Lentz, and J. Kindopp. 2017. Stranding of Chinook salmon (*Oncorhynchus tshawytscha*) and steelhead (*Oncorhynchus mykiss*) in the lower Feather River, 2017. Final Report. Department of Water Resources, Division of Environmental Services, Oroville, CA.

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

Williams, T. H., B. C. Spence, D. A. Boughton, R. C. Johnson, L. Crozier, N. Mantua, M. O'Farrell, and S. T. Lindley. 2016. Viability Assessment for Pacific Salmon and Steelhead Listed Under the Endangered Species Act: Southwest.

Wooster, T. W. 1966. A Report to the California State Water Rights Board on the Fish and Wildlife Resources of the Feather River to be Affected by The Oroville Dam and Reservoir, Thermalito Diversion, Thermalito Forebay, and Thermalito Afterbay and Measures Proposed to Maintain These Resources.

Yoshiyama, R. M., E. R. Gertstung, F. W. Fisher, and P. B. Moyle. 2001. Historical and Present Distribution of Chinook Salmon in the Central Valley Drainage of California. Fish Bulletin 179:71-176.

Yuba County Water Agency (YCWA). 2012 (December). Non-ESA listed fish populations downstream of Englebright Dam. Technical Memorandum 3-9. Yuba River Development Project, FERC Project No. 2246.

Yuba County Water Agency (YCWA). 2013a. Project effects on fish facilities associated with Daguerre Point Dam. Technical Memorandum 7-12. Yuba River Development Project, FERC Project No. 2246. May.

Yuba County Water Agency (YCWA). 2013b. ESA/CESA-listed salmonids downstream of Englebright Dam. Technical Memorandum 7-8. Yuba River Development Project, FERC Project No. 2246. April.