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

Refer to NMFS ECO #: WCR-2023-00854

December 6, 2023

Wade McMaster
Forest Supervisor, Mendocino National Forest, R5
825 North Humboldt Avenue
Willows, CA 95988

Re: Endangered Species Act Section 7(a)(2) Biological Opinion and Magnuson–Stevens Fishery Conservation and Management Act Essential Fish Habitat Response for the 20-year Sycamore Grove Boat Launch Maintenance Project

Dear Mr. Wade McMaster:

Thank you for your letter of May 22, 2023, 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 20-year Sycamore Grove Boat Launch Maintenance Project.

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

Based on the best available scientific and commercial information, the biological opinion concludes that the 20-year Sycamore Grove Boat Launch Maintenance Project is not likely to jeopardize the continued existence of the federally listed threatened Central Valley spring-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), threatened California Central Valley steelhead (*O. mykiss*) distinct population segment (DPS), endangered Sacramento River winter-run Chinook salmon (*O. tshawytscha*) ESU or the threatened southern DPS of North American green sturgeon (*Acipenser medirostris*) and is not likely to destroy or adversely modify the designated critical habitats of the above listed species. For the above species, NMFS has included an incidental take statement with reasonable and prudent measures and terms and conditions that are necessary and appropriate to avoid, minimize, or monitor incidental take of listed species associated with the project.

Please contact Marie Ferguson in the NMFS California Central Valley Office via email at marie.ferguson@noaa.gov or via phone at (916) 930-3620 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-WCR2023-SA00032

Wade McMaster, U.S. Forest Service, California, wade.mcmaster@usda.gov
Loren Everest, U.S. Forest Service, California, loren.everest@usda.gov
Joseph Chow, U.S. Forest Service, California, joseph.chow@usda.gov

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

20-year Sycamore Grove Boat Launch Maintenance Project

NMFS Consultation ECO Number: WCR-2023-00854

Action Agency: U.S. Forest Service (USFS)

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*) evolutionarily significant unit (ESU)	Threatened	Yes	No	Yes	No
Sacramento River winter-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU	Endangered	Yes	No	Yes	No
California Central Valley steelhead (*Oncorhynchus mykiss*) distinct population segment (DPS)	Threatened	Yes	No	Yes	No
Southern DPS 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: **December 6, 2023**

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 U.S.C. 1531 *et seq*.), as amended, and implementing regulations at 50 CFR part 402.

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

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

1.2. Consultation History

- On February 1, 2023, the U.S. Forest Service (USFS) informed NOAA's National Marine Fisheries Service (NMFS) of the 20-year Sycamore Grove Boat Launch Maintenance Project (project) proposal to conduct annual boat ramp dredging maintenance activities located at the Red Bluff Recreation Area on the Grindstone District of the Mendocino National Forest on the Sacramento River.
- On March 15, 2023, USFS requested technical assistance from NMFS to discuss project details and listed species, critical habitat, and EFH in the action area.
- On March 23, 2023, NMFS and USFS met to discuss the proposed annual maintenance activities and spring-season work window (generally, March 1 – May 31), as well as listed species potentially affected by the action. NMFS sent an email to USFS describing sensitive life stages present in the action area during the proposed work window. The following NMFS recommendations were accepted by USFS to minimize potential impacts to listed species in the action area:
    - Coordinate with the U.S. Fish and Wildlife Service's Red Bluff Office (RBFWO) prior to conducting the proposed activities to ensure minimal presence of listed species.
    - In the event of a storm, halt project activities for three to five days to ensure listed fish species moving with the increased flow have moved past the action area.
- On May 22, 2023, NMFS received a letter requesting formal consultation and a Biological Assessment (BA) from USFS for the project.

- On June 5, 2023, NMFS sent a letter to USFS requesting additional information and provided recommendations to minimize impacts to listed species and critical habitat. From June 5, 2023 to June 25, 2023, NMFS and USFS met multiple times to discuss components of the action, including timing and minimization measures. USFS additionally requested to conduct work outside of the March 1 – May 31st in-water work window for emergency purposes. NMFS provided additional recommendations to minimize impacts to listed species in the action area and USFS accepted the following recommendations:
    - Unless required for emergency purposes, maintenance activities will primarily be conducted during the proposed in-water work window of January 1 to May 31 of each year.
    - Unless required for emergency purposes, in-water work activities will not occur between June 1 to October 31 of each year.
    - Turbidity monitoring will be conducted at the boat ramp site and 1,000 feet downstream. If turbidity measured 1,000 feet downstream of the site exceeds double the measurement upstream of the site, then work will stop and NMFS will be contacted within 24 hours.
- On July 27, 2023, a final meeting was held between NMFS and USFS to clarify final project details, and as sufficient information had been provided, consultation was initiated.

On July 5, 2022, the U.S. District Court for the Northern District of California issued an order vacating the 2019 regulations that were revised or added to 50 CFR part 402 in 2019 ("2019 Regulations," see 84 FR 44976, August 27, 2019) without making a finding on the merits. On September 21, 2022, the U.S. Court of Appeals for the Ninth Circuit granted a temporary stay of the district court's July 5 order. On November 14, 2022, the Northern District of California issued an order granting the government's request for voluntary remand without vacating the 2019 regulations. The District Court issued a slightly amended order two days later on November 16, 2022. As a result, the 2019 regulations remain in effect, and we are applying the 2019 regulations here. For purposes of this consultation and in an abundance of caution, we considered whether the substantive analysis and conclusions articulated in the biological opinion and incidental take statement would be any different under the pre-2019 regulations. We have determined that our analysis and conclusions would not be any different.

1.3. Proposed Federal Action

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

1.3.1. Project Description

The project proposes annual sediment dredging and cobble/gravel deposition (collectively referred to as "maintenance activities") over a 20-year period at the boat launch ramp in the

USFS's Sycamore Grove Recreation Area (within the USFS Lake Red Bluff Recreation Area) on the east bank of the Sacramento River in Red Bluff, California (Tehama County) at latitude 40.15358 and longitude -122.19837. The boat ramp and associated facilities are managed and maintained by the USFS Mendocino National Forest (MNF), Grindstone Ranger District. Sediment accumulates approximately 15-20 feet from the end of the boat ramp during winter season high water flows, making the ramps unusable, or limiting capacity to launch boats. Additionally, dependent on sediment deposition dynamics, a scour hole exists at the end of the boat ramp creating a "drop off" at the edge of the boat ramp, further limiting capacity to launch boats, especially during low flows. The boat ramp facility allows access to the river for multiple uses including recreational, state and federal resource agency and private entity fish and water quality monitoring, and state and local law enforcement patrol and emergency response.

Proposed activities in the streambed include annual removal/dredging of accumulated sediment from a 0.02 acre area approximately 15-20 feet from the end of the boat ramp. The total estimated amount of sediment to be removed will be 20 cubic yards or less per year and depth of dredging is estimated to be between 1.5 and 3.0 feet; however, the amount of material to be dredged and removed, as well as dredging depth, would differ between wet and dry years. Approximately 0.001 acres of native river cobble or gravel will be deposited in the streambed in order to fill the scour hole that exists at the end of the boat ramp, but may vary depending on seasonal river conditions.

An excavator or backhoe will be used to remove material and side-cast or transfer it directly into a dump truck or loader. The dump truck or loader will not enter the water and will be located on a paved surface adjacent to the boat ramp. It will only be used to transfer the material to a predetermined stockpile offsite location approximately 1 mile inland from the boat ramp location (above the 100-year floodplain mark). The excavator would have an approximate 30-foot arm reach and 36-inch bucket with perforated holes for the release of water prior to side-casting or transferring the sediment. The excavator or backhoe will only work off of the paved boat ramp (not along the river banks) and the bucket arm will primarily enter the water for maintenance activities. For dredging activities, the track pads and bottom rollers of the excavator or backhoe will additionally need to enter the water to access the dredging area. For cobble/gravel deposition activities, the bucket arm will be the only part of the equipment to enter the water. No riparian or woody vegetation would be removed or disturbed. As equipment will only work on the paved boat ramp, temporary ramps will not need to be constructed into the water.

Proposed maintenance activities are estimated to occur 1-3 times a year and in-water work would last approximately 30 minutes to 4 hours per occurrence; however, the frequency will vary depending on seasonal river and weather conditions and river accessibility public needs. Maintenance activities will not exceed 3 occurrences per year. While frequency may vary, the proposed activities are expected to have 1-3 days of disturbance per year with 4-12 hours per year of in-water disturbance. While maintenance activities will primarily be conducted during the proposed in-water work window of January 1 to May 31 of each year, maintenance activities may need to be conducted outside of the in-water work window for emergency purposes and to maintain river access. Because the boat ramp is used throughout the year for multiple uses, including local law enforcement patrol and emergency response, USFS indicated it is necessary to maintain river access throughout the year. Environmental conditions, such as low flows or

sediment inundation from flood events, prevent boats from accessing the river at the boat ramp, thus requiring the need for maintenance when these conditions occur. The proposed action is implementing maintenance activities at the boat ramp over a 20-year period.

1.3.2. Avoidance, Minimization and Conservation Measures

Measures will be implemented to ensure impacts to Central Valley (CV) spring-run Chinook salmon (*Oncorhynchus tshawytscha*) evolutionarily significant unit (ESU), California Central Valley (CCV) steelhead (*O. mykiss*) distinct population segment (DPS), Sacramento River (SR) winter-run Chinook salmon (*O. tshawytscha*) ESU, and the southern DPS (sDPS) of North American green sturgeon (*Acipenser medirostris*) and their habitat are minimized to the greatest extent possible.

1.3.2.1 General Measures

- All equipment will be free of invasive species or cleaned to prevent the spread of aquatic invasive species and other organisms.
- The project lead for maintenance activities will notify the USFS Grindstone Ranger District biology staff of upcoming project implementation as soon as implementation dates are set.

1.3.2.2 Minimization of Impacts to Anadromous Fish Species

- For informational purposes, within 5 calendar days when maintenance activities are expected to occur, a qualified USFS Grindstone Ranger District fisheries biologist will examine the project site to evaluate and determine the presence of listed anadromous fish species, salmonid redds, and green sturgeon eggs, including 100-feet upstream and 350-feet downstream of the project site.
- Prior to implementation of in-water activities, USFS will coordinate and check in with the Red Bluff, California, U.S. Fish and Wildlife Service Office (RBFWO) to avoid or ensure minimal exposure to listed anadromous fish species.
- A qualified USFS Grindstone Ranger District fisheries biologist will monitor in-water work to ensure minimization of impacts to listed species and their critical habitat. No capture, handling, or electrofishing of fish will occur.
- Sediment removal and dredging will begin in the dry portion of the site and gradually work toward the water's edge to encourage any juvenile fish at the water's edge to volitionally move away from the area.
- All in-water activities will occur during daylight hours to avoid times when juvenile and larval green sturgeon may be more active.
- Unless required for emergency purposes, maintenance activities will be conducted during the proposed in-water work window of January 1 to May 31 of each year when sensitive migratory, spawning, rearing juvenile, and larval life stages for SR winter-run Chinook salmon and green sturgeon are least likely to be present in the action area.
- Unless required for emergency purposes, in-water work activities will not occur between June 1 to October 31 of each year to minimize impacts to SR winter-run Chinook salmon adults migrating through the action area to reach spawning grounds, as well as rearing

green sturgeon juveniles in the action area. In-water work activities will additionally be avoided during spring pulse flows on Clear Creek which signal anadromous fish to migrate up the Sacramento River, through the action area, and into Clear Creek.

- In the event a storm occurs, in-water activities will cease work and wait 3-5 days post storm before commencing to ensure that anadromous fish moving with that flow are given time to pass the action area.

1.3.2.3 Minimization of Impacts to Riparian Habitat

- No removal of or disturbance to riparian vegetation will occur. Any fill material that is removed where riparian vegetation could be impacted will be removed with hand tools or other similar means.
- During maintenance activities, the excavator or backhoe will remain on the boat ramp footprint (or other paved surfaces in the action area). Heavy equipment will avoid bank and riparian areas.

1.3.2.4 Minimization of Impacts to Water Quality

- In lieu of silt curtains, turbidity monitoring will be conducted at the boat ramp site and 1,000 feet downstream. If turbidity measured 1,000 feet downstream of the site exceeds double the measurement upstream of the site, then work will stop and NMFS will be contacted within 24 hours. In the event that this occurs, NMFS will coordinate with USFS on conditions that may be causing the high turbidity levels and a silt curtain will be installed at that time.
- Monitoring of water turbidity and settleable materials will be conducted in accordance with the Clean Water Act (CWA) Section 401 certification through consultation with the Central Valley Regional Water Quality Control Board (RWQCB), as well as a CWA Section 404 permit from the U.S. Army Corps of Engineers (USACE). USFS National Best Management Practices will also be used to control turbidity and settleable material (USDA FS 2012).
- Pollution control measures will be taken to ensure that petroleum products or other harmful chemicals do not enter the Sacramento River as a result of project activities. USFS National Best Management Practices will be followed (USDA FS 2012).
- The amount of time equipment is stationed or working in the water will be minimized to the greatest extent feasible.
- If the substrate in the streambed is altered during work activities (outside of the dredged area), it will be returned to approximate pre-construction conditions after the work is completed.
- All equipment and machinery that contains fuel, oil or other petroleum products used during project activities will be inspected for petroleum leaks immediately prior to being mobilized to the project site each day prior to use. All equipment operated in or adjacent to the waterbody will be clean of oil, grease, and other contaminants and will be well maintained.
- All equipment refueling and / or maintenance will take place at least 100-feet from the channel.

- A hazardous spill prevention, containment measures, and response plan will be developed and implemented during maintenance activities, including having an emergency spill kit onsite during maintenance activities.
- Vegetable oil or other biodegradable hydraulic oil for heavy equipment hydraulics will be used when operating in or near water.
- In-water activities will occur during low flows and be avoided or suspended during high flow events.
- Maintenance activities will be conducted during dry periods when storms are not expected to occur to minimize the transport of sediment into the Sacramento River.
- Only clean washed native river cobble or gravel will be used.

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

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

2.1. Analytical Approach

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

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

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

identified PCEs, PBFs, or essential features. In this biological opinion, we use the term PBF to mean PCE or essential feature, as appropriate for the specific critical habitat.

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

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

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

2.2. Rangewide Status of the Species and Critical Habitat

This opinion examines the status of each species that is likely to be adversely affected by the proposed action. The status is determined by the level of extinction risk that the listed species face, based on parameters considered in documents such as recovery plans, status reviews, and listing decisions. This informs the description of the species' likelihood of both survival and recovery. The species status section also helps to inform the description of the species' "reproduction, numbers, or distribution" for the jeopardy analysis. The opinion also examines the condition of critical habitat throughout the designated area, evaluates the conservation value of the various watersheds and coastal and marine environments that make up the designated area, and discusses the function of the PBFs that are essential for the conservation of the species.

This biological opinion analyzes the effects of the proposed action on the following evolutionarily significant units (ESUs) and distinct population segments (DPSs): the endangered SR winter-run Chinook salmon (*Oncorhynchus tshawytscha*) ESU, the threatened CV spring-run Chinook salmon (*O. tshawytscha*) ESU, the threatened CCV steelhead (*O. mykiss*) DPS, and the threatened sDPS green sturgeon (*Acipenser medirostris*). See Table 1 for species status and Table 2 for critical habitat status.

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

Species and Recovery Plans	Listing Classification and Federal Register Notice	Status Summary
Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit (ESU) Final Recovery Plan for the ESUs of SR Winter-Run Chinook Salmon and Central Valley Spring-Run Chinook Salmon and the Distinct Population Segment of California Central Valley Steelhead (CV salmonid recovery plan, NMFS 2014)	Endangered, 70 FR 37160; June 28, 2005	According to the previous NMFS species status review (NMFS 2016c), the status of the SR winter-run Chinook salmon ESU, the extinction risk has increased from moderate risk to high risk of extinction since the 2007 and 2010 assessments. Based on the Lindley et al. (2007) criteria, the population is at high extinction risk in 2019. High extinction risk for the population was triggered by the hatchery influence criterion, with a mean of 66 percent hatchery origin spawners from 2016 through 2018. Several listing factors have contributed to the recent decline, including drought, poor ocean conditions, and hatchery influence. Thus, large-scale fish passage and habitat restoration actions are necessary for improving the SR winter-run Chinook salmon ESU viability. The overall status of the SR winter-run Chinook salmon ESU likely has declined since the 2015 viability assessment (Williams et al. 2016) due to the recent increase in hatchery influence. Viability information since the 2015 viability assessment (SWFSC 2022) has been incorporated into the analysis of this consultation and will be reflected in the updated status review in 2022.
Central Valley spring-run Chinook salmon ESU CV salmonid recovery plan (NMFS 2014)	Threatened, 70 FR 37160; June 28, 2005	According to the NMFS previous species status review (NMFS 2016b), the status of the CV spring-run Chinook salmon ESU, until 2015, had improved since the 2010, 5-year species status review. The improved status is due to extensive restoration, and increases in spatial structure with historically extirpated populations (Battle and Clear Creeks) trending in the positive direction. Recent declines of many of the dependent populations, high pre-spawn and egg mortality during the 2012 to 2016 drought, uncertain juvenile survival during the drought are likely increasing the ESU's extinction risk (Williams et al. 2016). Monitoring data showed sharp declines in adult returns from 2014 through 2020 (CDFW 2022). Viability information since the 2015 viability assessment (SWFSC 2022) has been incorporated into the analysis of this consultation and will be reflected in an updated status review in 2022.

Species and Recovery Plans	Listing Classification and Federal Register Notice	Status Summary
California Central Valley steelhead Distinct Population Segment (DPS) CV salmonid recovery plan (NMFS 2014)	Threatened, 71 FR 834; January 5, 2006	According to the NMFS previous species status review (NMFS 2016a), the status of CCV steelhead appears to have remained unchanged since the 2011 status review that concluded that the DPS was likely to become endangered within the foreseeable future throughout all or a significant portion of its range. Most natural-origin CCV populations are very small, are not monitored, and may lack the resiliency to persist for protracted periods if subjected to additional stressors, particularly widespread stressors such as climate change. The genetic diversity of CCV steelhead has likely been impacted by low population sizes and high numbers of hatchery fish relative to natural-origin fish. The life-history diversity of the DPS is mostly unknown, as very few studies have been published on traits such as age structure, size at age, or growth rates in CCV steelhead. While updated data on steelhead in the American River is mostly based on hatchery returns, natural spawning populations within the Sacramento tributaries have fluctuated, but showed a steady decline in the past 10 years (Scriven et al. 2018). Viability information since the 2015 viability assessment (Williams et al. 2016) has been incorporated into the analysis of this consultation (SWFSC 2022) and will be reflected in an updated status review in 2022.
Southern Distinct Population Segment (sDPS) of North American Green Sturgeon Recovery Plan for the Southern DPS of North American Green Sturgeon (*Acipenser medirostris*) (NMFS 2018)	Threatened, 71 FR 17757; April 7, 2006	According to the NMFS recent species status review (NMFS 2021) and the 2018 final recovery plan (NMFS 2018), some threats to the species have recently been eliminated, such as take from commercial fisheries and removal of some passage barriers. Also, several habitat restoration actions have occurred in the Sacramento River Basin, and spawning was documented on the Feather and Yuba rivers. However, the species viability continues to face a moderate risk of extinction because many threats have not been addressed, and the only spawning location that is known to support the sDPS occurs in a single reach of the main stem Sacramento River. Current threats include poaching and habitat degradation. A recent method has been developed to estimate the annual spawning run and population size in the upper Sacramento River so species can be evaluated relative to recovery criteria (Mora et al. 2018). Although passage improvements have occurred at Fremont Weir and spawning events have been documented in the Feather and Yuba rivers, no changes to the species status or threats are evident since the last review (NMFS 2021).

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

Critical Habitat	Designation Date and Federal Register Notice	Description
Sacramento River winter-run Chinook salmon ESU	June 16, 1993; 58 FR 33212	Designated critical habitat includes the Sacramento River from Keswick Dam (RM 302) to Chipps Island (RM 0) at the westward margin of the Sacramento-San Joaquin Delta (Delta); all waters from Chipps Island westward to the Carquinez Bridge, including Honker Bay, Grizzly Bay, Suisun Bay, and the Carquinez Strait; all waters of San Pablo Bay westward of the Carquinez Bridge; and all waters of San Francisco Bay north of the San Francisco-Oakland Bay Bridge from San Pablo Bay to the Golden Gate Bridge. The designation includes the river water, river bottom and adjacent riparian zones used by fry and juveniles for rearing. PBFs considered essential to the conservation of the species include: Access from the Pacific Ocean to spawning areas; availability of clean gravel for spawning substrate; adequate river flows for successful spawning, Incubation of eggs, fry development and emergence, and downstream transport of juveniles; water temperatures at 5.8–14.1°C (42.5–57.5°F) for successful spawning, egg incubation, and fry development; riparian and floodplain habitat that provides for successful juvenile development and survival; and access to downstream areas so that juveniles can migrate from spawning grounds to the San Francisco Bay and the Pacific Ocean. Although the current conditions of PBFs for SR winter-run Chinook salmon critical habitat in the Sacramento River are significantly limited and degraded, the habitat remaining is considered highly valuable.
Central Valley spring-run Chinook salmon ESU	September 2, 2005; 70 FR 52488	Critical habitat for CV spring-run Chinook salmon includes stream reaches of the Feather, Yuba and American rivers, Big Chico, Butte, Deer, Mill, Battle, Antelope, and Clear creeks, the Sacramento River, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water mark. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for CV spring-run Chinook salmon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

California Central Valley steelhead DPS	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, as well as portions of the northern Delta. Critical habitat includes the stream channels in the designated stream reaches and the lateral extent as defined by the ordinary high-water line. In areas where the ordinary high-water line has not been defined, the lateral extent will be defined by the bankfull elevation. PBFs considered essential to the conservation of the species include: Spawning habitat; freshwater rearing habitat; freshwater migration corridors; and estuarine areas. Although the current conditions of PBFs for steelhead critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.
sDPS of North American 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 main stem Sacramento River upstream from the I Street Bridge to Keswick Dam, the Feather River upstream to the fish barrier dam adjacent to the Feather River Fish Hatchery, and the Yuba River upstream to Daguerre Dam. Critical habitat in coastal marine areas include waters out to a depth of 60 fathoms, from Monterey Bay in California, to the Strait of Juan de Fuca in Washington. Coastal estuaries designated as critical habitat include San Francisco Bay, Suisun Bay, San Pablo Bay, and the lower Columbia River estuary. Certain coastal bays and estuaries in California (Humboldt Bay), Oregon (Coos Bay, Winchester Bay, Yaquina Bay, and Nehalem Bay), and Washington (Willapa Bay and Grays Harbor) are included as critical habitat for sDPS green sturgeon. PBFs considered essential to the conservation of the species for freshwater and estuarine habitats include: food resources, substrate type or size, water flow, water quality, migration corridor; water depth, sediment quality. In addition, PBFs include migratory corridor, water quality, and food resources in nearshore coastal marine areas. Although the current conditions of PBFs for sDPS green sturgeon critical habitat in the Central Valley are significantly limited and degraded, the habitat remaining is considered highly valuable.

2.2.1. Recovery Plans

In July 2014, NMFS released a final Recovery Plan for SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead (NMFS 2014, Recovery Plan). The Recovery Plan outlines actions to restore habitat and access, and improve water quality and quantity conditions in the Sacramento River to promote the recovery of listed salmonids. Key recovery

actions in the Recovery Plan include conducting landscape-scale restoration throughout the Delta, incorporating ecosystem restoration into Central Valley flood control plans that includes breaching and setting back levees, and restoring flows throughout the Sacramento and San Joaquin River basins and the Delta. In August 2018, NMFS released a final Recovery Plan for the sDPS green sturgeon (NMFS 2018), which focuses on fish screening and passage projects, floodplain and river restoration, and riparian habitat protection in the Sacramento River Basin, the Delta, San Francisco Estuary, and nearshore coastal marine environment as strategies for recovery.

2.3. 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 proposed action area is located at the USFS Sycamore Grove Recreation Area boat launch ramp on the east side of the Sacramento River in Red Bluff, California (Tehama County), approximately 1,000 ft. downstream of the Red Bluff Diversion Dam (RBDD). The USFS Sycamore Grove Recreation Area lies within the Red Bluff Recreation Area, which encompasses 488 acres of diversified habitat adjacent to the Sacramento River.

The action area is 10 acres, which includes a public boat launch ramp, in the Sacramento River. The action area for the proposed action consists of a project boundary that extends approximately 500 feet upstream and downstream and 100 feet from the bank to account for direct and indirect effects including noise, dust, storm water runoff, and turbidity, and other human disturbances resulting from the action. The estimated temporary impact areas are as follows: turbidity area (i.e., turbidity plume) is 1.4 acres, extending approximately 350 feet downstream and 100 feet from the bank; dredging area is 0.02 acres; and filling in the scour hole with cobble or gravel is 0.001 acres.

The Sycamore Grove Recreation Area boat launch ramp is open to the public for river access, recreation, fishing and boat launching during all times of the year. The site is maintained by the USFS and is used by state and federal resource agencies to access the river for fish monitoring activities and by state and local law enforcement agencies to access the river for river patrol.

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 Sacramento River originates near Mt. Shasta and flows south for 447 miles before reaching the Sacramento-San Joaquin River Delta and San Francisco Bay. Shasta Dam, which is located at RM 311 on the Sacramento River near Redding, California, was completed in 1945. It serves to control floodwaters and store surplus winter runoff for irrigation in the Sacramento and San Joaquin Valleys, maintain navigation flows, provide flows for the conservation of fish in the Sacramento River and water for municipal and industrial use, protect the Sacramento-San Joaquin Delta from intrusion of saline ocean water, and generate hydroelectric power. Keswick Dam was constructed nine miles downstream from Shasta Dam to create a 23,800 acre-foot afterbay for Shasta Lake and the Trinity River Division, which stabilizes uneven water releases from the power plants. Below Keswick Dam, the Anderson Cottonwood Irrigation District (ACID) Dam (RM 297) is seasonally in place to raise the water level for diversions into the ACID canal. The 59-mile reach of the Sacramento River between Keswick Dam (RM 302) and RBDD (RM 243) is commonly referred to as the Upper Sacramento River.

Flows in the Sacramento River in the 65-mile reach between Shasta Dam and RBDD are regulated by Shasta Dam and again, just downstream at Keswick Dam. Water stored in the reservoirs during the winter and spring is released in the summer and fall for municipal and industrial supply, irrigation, water quality, power generation, recreation, and fish and wildlife purposes. Historically, the upper Sacramento River was highly responsive to periodic precipitation events and seasonal variation. Since completion of the dams, flows are now lower in the winter and spring and higher in the summer and fall.

During July, August, and September, the mean monthly flows of the Sacramento River at Keswick since 1963 are nearly 400 percent higher than the mean monthly flows prior to 1943 (Department of Water Resources 1981, as cited in the Sacramento River Conservation Area Forum (SRCAF) handbook (2003)). In this reach, flows are influenced by tributary inflow. Major west-side tributaries to the Sacramento River in this reach of the river include Clear and Cottonwood Creeks. Major east-side tributaries to the Sacramento River in this reach of the river include Battle, Bear, Churn, Cow, and Paynes Creeks.

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

2.4.1. Status of the Species in the Action Area

The action area is located approximately 1,000 feet south of the RBDD on the mainstem Sacramento River which provides juvenile rearing habitat and functions as an important migration corridor for adult and juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon and CCV steelhead. Green sturgeon utilize the action area on the mainstem Sacramento River as a migratory corridor as well as for spawning and juvenile rearing.

The 2014 NMFS Recovery Plan (NMFS 2014) establishes the criteria for viable salmonid populations within the Central Valley to reach recovery of the species. The Recovery Plan described the viability of each existing population based on those criteria, which are then re-evaluated every 5 years to determine if the populations viability has changed. Core 1 watersheds possess the ability or potential to support a viable population. Core 2 populations have lower potential to support viable populations, due to lower abundance, or amount and quality of habitat; however, these populations provide increased life history diversity within the ESU/DPS and are likely to provide a buffering effect against local catastrophic occurrences that could affect other nearby populations.

The Recovery Plan identifies winter-run Chinook salmon in the mainstem Sacramento River below Keswick Dam as a Core 1 population with a moderate risk of extinction (Williams et al. 2011). Spring-run Chinook salmon in the mainstem Sacramento River (below Keswick Dam) are a Core 2 population with a high population extinction risk and CCV steelhead in this region of the Sacramento River are also a Core 2 population, but with an uncertain population extinction risk. Each ESU/DPS is broken down into several diversity groups, which have levels of recovery criteria built within them that also evaluate the viability of a species. The action area is on the mainstem Sacramento River, which serves as the main migratory corridor for three of the four major diversity groups for salmonids (the Basalt and Porous Lava group, the Northwestern California group, and the Northern Sierra Nevada Group), as well as the whole DPS for green sturgeon.

2.4.1.1 Sacramento River Winter-run Chinook Salmon

SR winter-run Chinook salmon utilize the action area of the Sacramento River for adult migration and juvenile rearing and emigration. Spawning is primarily currently limited to the Upper Sacramento River (between Keswick Dam and RBDD), with managed flows out of Shasta Dam, and occurs from May to August (Williams 2006). However, while annual adult returns and juvenile production has been variable, SR winter-run Chinook salmon spawning and juvenile production has also been confirmed in Battle Creek since 2020 as a result of introduction efforts.

Adult winter-run occur at medium relative abundance in the Sacramento River basin from November to July (Myers et al. 1998, Yoshiyama et al. 1998, Moyle 2002), with upstream migration through the action area primarily occurring from December through April. The majority of the winter-run Chinook salmon adults pass RBDD between January and May (Hallock and Fisher 1985), with the peak typically occurring during March and April (Snider et al. 2001). Data on the temporal distribution of SR winter-run Chinook salmon upstream migration suggest that in wet years about 50 percent of the run has passed the RBDD by March, and in dry years, migration is typically earlier, with about 72 percent of the run having passed the RBDD by March (Poytress et al. 2014). Juveniles out-migrate through the action area on the Sacramento River from July to March, peaking in September into early October (Vogel and Marine 1991, Poytress et al. 2014), and the timing is thought to be highly influenced by winter rain events and subsequent river flows (Martin et al. 2001).

Since 2007, SR winter-run Chinook salmon have declined in abundance with a low of 827 spawning adults in 2011 (NMFS 2016c). As reported in the previous 5-year status review (NMFS 2016c), the 10-year trend in run size is -0.15 which suggests an annual 15% population

decline. This declining trend is likely due to a combination of factors, such as poor ocean productivity (Lindley et al. 2009), drought conditions from 2007 to 2009 and 2012 to 2015, and low in-river survival (NMFS 2016c).

Adult SR winter-run Chinook salmon returns in 2016 to 2018 were low, as expected, due to poor in-river conditions for juveniles from brood years 2013-2015 during drought years. The adult SR winter-run Chinook salmon escapement estimates have since increased with the escapement estimates for 2020 at 6,199, 2021 at 9,998, and 2022 at 5,443 adults. With the most recent drought conditions from 2020 through 2022, it is still yet to be determined how the cohorts from those conditions will fare. Due to very high in-river temperatures, poor water quality, and Thiamine deficiency, juvenile recruitment from those years is expected to be very poor. Ocean abundance of salmon in early 2023 led to the closing of the commercial and recreational salmon fishery off the coast of California (PFMC 2023), followed by an inland salmon fishery closure by the California Department of Fish and Wildlife (CDFW 2023a).

2.4.1.2 Central Valley Spring-run Chinook Salmon

The action area on the Sacramento River serves as a primary upstream adult and downstream juvenile migratory corridor for CV spring-run Chinook salmon populations in Clear, Battle, and Cottonwood Creeks and provides juvenile rearing habitat. Adult upstream migration through the action area occurs between March and September, primarily in May and June (Myers et al. 1998, Yoshiyama et al. 1998, Moyle 2002). Spring-run Chinook migrate, hold, and spawn during this period with spawning only occurring in the upper portion of the Sacramento River and tributaries (NMFS 2014). Juvenile outmigration through the action area occurs in the fall through spring, peaking with high relative abundance from November through January (Myers et al. 1998).

2.4.1.3 California Central Valley Steelhead

CCV steelhead are well distributed throughout the Central Valley below the major rim dams (Good et al. 2005). The action area on the mainstem Sacramento River serves as a primary adult and juvenile migratory corridor for both upstream and downstream migration for all Sacramento River Basin populations, connecting spawning habitat within the Sacramento River and tributaries to the San Francisco Bay estuary and the Pacific Ocean. Adult and juvenile CCV steelhead can be present in the action area and Sacramento River year-round, although their presence often coincides with high-flow events during the late fall through spring. Migrating adults can be found in the action area primarily during the fall and winter seasons, increasing in mid-August to October and peaking at high relative abundance in later September to early October (Hallock et al. 1961, McEwan 2001). Juvenile steelhead occur with greater abundance from March to June and October to November (Hallock et al. 1961, McEwan 2001, NMFS 2014). Juvenile rearing tends to occur in areas with cool, clear fast-moving water where riffle habitat is predominant over pool habitat (Moyle 2002). Therefore, it is more likely that juveniles found within the action area will be migrating, rather than rearing.

2.4.1.4 sDPS Green Sturgeon

The action area on the mainstem Sacramento River serves as spawning habitat, juvenile rearing habitat, and as a primary migration corridor for the sDPS of green sturgeon. The upper mainstem

Sacramento River is the only area where consistent annual spawning by sDPS green sturgeon has been confirmed via the presence of eggs and larvae (Poytress et al. 2015); however, spawning is known to occur on the Yuba River below Daguerre Point Dam (CDFW 2018, 2019) and in the Feather River near the Thermalito Bay outlet (Seesholtz et al. 2015). Although observations of green sturgeon have been found as far upstream as near the mouth of Cow Creek (RM 280), spawning occurring above RBDD has only been documented as far upstream as the confluence with Ink's Creek (RM 265) (Poytress et al. 2013). Other confirmed spawning sites are at the mouth of Payne's Creek (RM 267), and at the RBDD. Sexually mature adult sturgeon occur in the action area of the Sacramento River between river kilometer (RKM) 332.5 and 451 throughout the year (Poytress et al. 2015, DuBois and Danos 2018, Mora et al. 2018). Adult sturgeon occur in high relative abundance between April and mid-November.

Spawning occurs from April to July (Poytress et al. 2015) with broadcasting and fertilization of eggs occurring in relatively fast water and most likely in depths greater than 5 meters (e.g., Wyman et al. 2018). Larvae may be present in the action area following hatching and are found predominantly in the thalweg or mid-channel but have been observed along the east and west river margins in the action area over the years. Exogenous feeding larvae (i.e., larvae that drift out of incubation areas and feed on passive insect drift or insects attached to medium to large substrate classes) are weak swimmers and use the thalweg for higher velocity waters to re-distribute from hatching areas (RBFWO 2023). Larvae occur in the Sacramento River above RKM 332.5 between March and October, peaking from May to July (Poytress et al. 2015, Heublein et al. 2017). Young juveniles (less than 5 months old) occur above RKM 332.5 in the Sacramento River from April to December, peaking at high relative abundance from July to October (Poytress et al. 2015, Heublein et al. 2017); however, it is unknown how long juveniles stay in the action area before moving downstream. Juveniles older than 5 months, occur in the Sacramento River throughout the year, peaking in high relative abundance from August to December (Poytress et al. 2015, Heublein et al. 2017). There is insufficient information available on how long juveniles rear in the mainstem Sacramento River, but it is likely that at least some juvenile rearing occurs in the river prior to their entry into the Delta. Therefore, the exact mechanisms of habitat utilization by juveniles within the action area is unknown, but we do expect subadult green sturgeon could be present in the action area year- round.

2.4.2. Status of Critical Habitat in the Action Area

Designated critical habitat occurs in the action area within the Sacramento River for all four listed species discussed in this opinion. PBFs that are essential for the conservation of winter-run Chinook salmon include migratory access between the Pacific Ocean and spawning areas for adults and juveniles, adequate river flows for downstream transport of juveniles, and riparian and floodplain habitat that provides for successful juvenile development and survival. PBFs for spring-run Chinook and steelhead critical habitat in the action area include freshwater rearing habitat and freshwater migration corridors. Essential PBFs of freshwater riverine critical habitat for sturgeon include food resources, suitable substrate type or size, water flow, water quality, migration corridor, adequate water depth, and sediment quality.

The intended conservation roles of habitat in the action area are to provide appropriate freshwater rearing and migration conditions for juveniles and unimpeded freshwater migration and spawning conditions for adults. However, the conservation condition and function of this

habitat has been severely impaired by various factors. The result has been the reduction in quantity and quality of several essential features of habitat required by salmonids and sturgeon to grow and survive. Despite the degraded condition of habitat within the action area, its intrinsic value remains high for the conservation of all federally listed fish species in the Central Valley.

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

The Sacramento River has been degraded from its historic condition and many anthropomorphic and naturally occurring factors have led to the decline of anadromous fish in the system. The combination of degraded physical habitat characteristics, fish passage barriers, and changes in hydrology resulting from dams and diversions since the mid-1800s has been associated with salmonid and green sturgeon declines within the Sacramento River watershed. Altered flow regimes can influence migratory cues, water quality (including contaminants, dissolved oxygen and nutrients for primary productivity) and temperature.

Barriers and Habitat Loss

The flows in the action area have been highly modified through dams and the export of water from upstream areas and the delivery of water to downstream areas. Dams are considered a major cause of the widespread decline of CV salmonids. Impassible barriers and resulting blockage and loss of historic spawning habitat were identified as a threat and reason for listing winter-run and spring-run Chinook salmon, steelhead, and green sturgeon in their corresponding recovery plans (NMFS 2014, 2018). Historic spawning habitats are blocked, resulting in the shifting of spawning distributions for listed species.

Shasta and Keswick Dams (upstream of the action area) have presented impassable barriers to anadromous fish since 1944, blocking access to historical spawning and rearing habitat (Billington et al. 2005). These barriers greatly reduced species' ranges, abundance, genetic diversity, life history variability, and local adaptation (Lindley et al. 2007). Dams block passage to spawning areas that are of greater intrinsic value, so populations natal to the Sacramento River and its tributaries above dams are currently forced to complete any natural spawning at a lower elevation than they otherwise would have. Spawning in sub-par areas can involve higher than optimal water temperatures, degraded water quality due to anthropogenic pollution, and decreased water flow and velocity needs to oxygenate the developing eggs. The RBDD historically presented partial barriers to salmonid migration by utilizing gates to divert water for agriculture and urban uses. The decommissioning of RBDD in 2013 was an important step in barrier removal, as the sDPS of green sturgeon could reach spawning areas above RBDD during all months of the year (Steel et al. 2018). Anderson-Cottonwood Irrigation District (ACID) Diversion Dam continues to present an impassable barrier to green sturgeon on the mainstem Sacramento River.

Dams also retain coarse sediments that would normally re-supply spawning beds with appropriately sized gravel, which has resulted in an alluvial sediment deficit and reduction in fish habitat quality within the Upper Sacramento River reach as well as contributed to gradual loss of suitable gravel from spawning grounds (Wright and Schoellhamer 2004). In addition to the reduction of sediment supply, recruitment of large woody material to the river channel and floodplain has also declined due to a reduction in bank erosion and blockage of wood transport

by Shasta Dam. Spawning, rearing, and migration corridor PBFs have been degraded as a result of dam construction. On the Sacramento River, features, such as scour pools, borrow pits, and swales within bypasses can also potentially strand green sturgeon when bypass flooding flows recede.

Predation

Predation on juveniles rearing and migrating through the Sacramento River impacts species from all populations. Predation is an ongoing threat to larvae and juveniles of listed salmonids and sturgeon, due to native species (e.g., Sacramento sucker, pikeminnow, prickly sculpin) and non-native species (e.g., striped bass, carp, American shad, crayfish, centrarchids, catfish, non-native minnows) (Lindley et al. 2011, NMFS 2014, NMFS 2018). Species, such as the Sacramento pikeminnow, are native to the Sacramento River basin and have co-evolved with the anadromous salmonids in this system. However, rearing conditions in the Sacramento River today (e.g., warm water, low-irregular flow, standing water, and water diversions), compared to its natural state and function decades ago in the pre-dam era, are more conducive to warm water species, such as Sacramento pikeminnow and striped bass than to native salmonids. Tucker et al. (1998) reported that predation during the summer months by Sacramento pikeminnow on juvenile salmonids increased to 66 percent of the total weight of stomach contents in the predatory pikeminnow. The presence of man-made structures in the freshwater habitat likely contributes to increased predation levels.

Water Quality and Temperature

Chinook salmon, and particularly Sacramento River winter-run Chinook salmon, are dependent upon the provision of suitably cool water temperatures during the spawning, embryo incubation, and juvenile rearing period. Water temperatures in the Sacramento River are the result of interactions among air temperature, water volume, and releases from Shasta, Whiskeytown, and Keswick Reservoirs. However, the ability to meet temperature requirements has proven extremely difficult during drought years. The quality of surface water downstream of Keswick Dam is also influenced by other human activities along the Sacramento River downstream of the dam, including historical mining, agricultural, and municipal and industrial activities.
The main sources of water in the Sacramento River below Keswick Dam are rain and snowmelt that collect in upstream reservoirs and are released in response to water needs or flood control. The quality of water in the Sacramento River is relatively good; only during conditions of stormwater-driven runoff are water quality objectives typically not met (Domagalski et al. 2000). Water quality issues within the upper Sacramento River include the presence of mercury, pesticides such as organochlorine, trace metals, turbidity, and toxicity from unknown origin (CALFED 2000).

Urbanization

The areas surrounding the Sacramento River have been heavily urbanized. This has likely increased the amount of contaminant loading in the aquatic ecosystem. Heavy metals, Polycyclic Aromatic Hydrocarbons, petroleum products, plastics, fertilizer and many other contaminants can enter the river via urban runoff. Shoreline areas along the Sacramento River have been

developed over time, including artificially created levees. Levees and other shore-side development substantially reduce density and diversity of riparian vegetation and lead to decreased recruitment of large woody material (LWM), resulting in a loss of habitat complexity, which is a critical component of the freshwater rearing PBF.

Riparian vegetation provides a host of ecosystem services and its removal has diminished habitat value within the action area. Riparian vegetation plays a key role in the value of rearing habitat for conservation of all salmonid life stages by providing shade to lower stream temperatures, increasing the recruitment of large woody material into the river, increasing habitat complexity, providing shelter from predators and enhancing the productivity of aquatic macroinvertebrates (Anderson and Sedell 1979, Pusey and Arthington 2003). It has also been shown to directly influence channel morphology and may be directly correlated with improved water quality in aquatic systems (Schlosser and Karr 1981, Dosskey et al. 2010).

2.4.4. Climate Change

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

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

Projected warming due to climate change is expected to affect Central Valley Chinook salmon. Because the runs are restricted to low elevations as a result of impassable rim dams, if temperatures rise by 5°C (9°F), it is questionable whether any Central Valley Chinook salmon populations can persist (Williams 2006). Based on an analysis of an ensemble of climate models and emission scenarios and a reference temperature from 1951- 1980, the most plausible projection for warming over Northern California is 2.5°C (4.5°F) by 2050 and 5°C by 2100, with a modest decrease in precipitation (Dettinger 2005). Chinook salmon in the Central Valley are at the southern limit of their range, and warming will shorten the period in which the low elevation habitats used by naturally- producing fall-run Chinook salmon are thermally acceptable. This

would particularly affect fish that emigrate as fingerlings, mainly in May and June, and especially those in the San Joaquin River and its tributaries.

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

CV spring-run Chinook salmon adults are vulnerable to climate change, because they 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 provided by springs, will be more susceptible to impacts of climate change. In years of extended drought and warming water temperatures, unsuitable conditions may occur even in tributaries with cool water springs. Additionally, juveniles often rear in the natal stream for one to two summers prior to emigrating and would be susceptible to warming water temperatures.

Although steelhead will experience similar effects of climate change to Chinook salmon, as they are also blocked from the vast majority of their historic spawning and rearing habitat, the effects may be even greater in some cases, as juvenile steelhead need to rear in the stream for one to two summers prior to emigrating as smolts. In the Central Valley, summer and fall temperatures below the dams in many streams already exceed the recommended temperatures for optimal growth of juvenile steelhead, which range from 14°C to 19°C (57°F to 66°F). Several studies have found that steelhead require colder water temperatures for spawning and embryo incubation than salmon (McCullough et al. 2001).

The sDPS green sturgeon spawn primarily in the Sacramento River in the spring and summer. The Anderson Cottonwood Irrigation District (ACID) Dam is considered the upriver extent of green sturgeon passage in the Sacramento River. The upriver extent of green sturgeon spawning, however, is approximately 30 kilometers downriver of ACID where water temperatures are higher than at ACID during late spring and summer. Thus, if water temperatures increase with climate change, temperatures adjacent to ACID may remain within tolerable levels for the embryonic and larval life stages of green sturgeon, but temperatures at spawning locations lower in the river may be more affected. It is uncertain, however, if green sturgeon spawning habitat exists closer to ACID, which could allow spawning to shift upstream in response to climate change effects. Successful spawning of green sturgeon in other accessible habitats in the Central

Valley (i.e., the Feather River) is limited, in part, by late spring and summer water temperatures. Similar to salmonids in the Central Valley, green sturgeon spawning in the major lower river tributaries to the Sacramento River are likely to be further limited if water temperatures increase and suitable spawning habitat remains inaccessible.

Stream flow is a highly important variable and driving mechanism in fluvial ecosystems and climate has been identified as a landscape-scale driver of flow rates (Minshall 1988). Multiple climatological and hydrologic model predictions indicate that flows in the CCV will decrease throughout the 21st century as warming trends continue. Salmonids in the Sacramento River will likely face a decrease in flows, resulting in potentially lethal or sub-lethal water temperatures in summer months, impaired migration and decreased egg to fry recruitment. In addition to altered flow regimes, some other aspects of stream systems that are particularly sensitive to changes in climate are sediment transport/channel alterations, nutrient loading and rates of nutrient cycling, fragmentation and isolation of cold-water habitats, altered exchanges with the riparian zone and life history characteristics of many aquatic insects (Meyer et al. 1999). Current warming trends and model predictions indicate that it is likely that climate change will result in some direct and indirect adverse effects to salmonids in the Sacramento River in the 21st century.

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

2.4.5. Species Survival and Recovery in the Action Area

The Sacramento River contains spawning, rearing, and migratory habitat for SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon. The portion of the Sacramento River within the action area contains rearing and migration corridor PBFs for all four species and spawning PBFs for green sturgeon and is of high conservation value because of the location and habitat features that are essential to meeting almost all of the freshwater life history requirements of these species.

The Central Valley Salmonid Recovery Plan (NMFS 2014) included recovery criteria (species down/delisting) and diversity group priorities. Historically, SR winter-run Chinook salmon only occurred in the Basalt and Porous Lava diversity group. The recovery criteria include reestablishment of 3 viable populations, including the current population in the mainstem Sacramento River (downstream of Shasta Dam and Keswick Dam), as well as priority reintroductions into Battle Creek (underway), and one of the rivers upstream of Shasta Dam (underway on the McCloud River).

Recovery criteria and diversity group priorities for CV spring-run Chinook salmon includes establishment of two viable populations in the Basalt and Porous Lava diversity group (Battle Creek; and reintroduction to a river upstream of Shasta Dam (likely the McCloud River)), one in the Northwestern California diversity group (Clear Creek; and maintaining Core 2/dependent population in Cottonwood/Beegum Creek), four in the Northern Sierra Nevada diversity group

(Mill, Deer, Butte Creeks; and reintroduction into the Yuba River, upstream of Englebright Dam), as well as maintaining Core 2/dependent populations (in Feather River, the Yuba River downstream of Englebright Dam, and Antelope Creek).

Finally, for CCV steelhead, recovery criteria and diversity group priorities include two viable populations in the Basalt and Porous Lava diversity group (Battle Creek; reintroduction into the McCloud River; and maintaining Core 2/dependent populations in Cow Creek and other tributaries), one population in the Northwestern California diversity group (Clear Creek; and maintaining Core 2 population in Cottonwood/Beegum Creek), four populations in the Northern Sierra Nevada diversity group (Antelope, Deer, and Mill Creeks; reintroduction in the Yuba River upstream of Englebright Dam), as well as maintaining Core 2 populations (in lower Yuba River, Butte Creek, Feather River, Big Chico Creek, Auburn Ravine, and the American River).

2.5. Effects of the Action

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

2.5.1. Effects to Listed Species

The preferred in-water work window of January 1 to May 31 was developed to avoid project effects to migratory adult and out-migrating and rearing juvenile SR winter-run Chinook salmon and migratory, spawning, rearing juvenile, and larval life stages for green sturgeon to the greatest extent possible and to avoid peak migrations for these species. However, this work window does not preclude adult and juvenile SR winter-run Chinook salmon and adults (migrating and spawning), larval, and young juvenile (less than 5 months old) green sturgeon presence. It does identify a time frame when SR winter-run Chinook salmon and green sturgeon are minimally present in the system and to avoid the most sensitive life stages to the greatest extent possible.

While maintenance activities will primarily occur during the in-water work window stated above, it is possible that maintenance activities will be conducted outside of this timeframe and throughout the year for emergency purposes. For these reasons, effects of the proposed action are analyzed in correspondence to the listed fish species and life stages that may be present in the action area throughout the year. NMFS expects the following life stages of listed species to be present in the action area during the year including migrating adult and migrating and rearing juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead and all life stages of sDPS green sturgeon.

Increased Sedimentation and Turbidity

Increased sedimentation and turbidity may result from the proposed project. Disturbance from heavy equipment within and outside of the channel and disturbance of riverbed sediments from

dredging would cause temporary increased turbidity and suspended sediments. Disturbance of sediments could lead to a degradation of water quality. An increase in water turbidity and/or suspended sediments could cause injury or mortality to all species and life stages, if concentrations were at elevated levels for an extended period of time and fish were present.

Increased sedimentation and turbidity could have short-term and long-term adverse physiological and behavioral effects to fish. High concentrations of suspended sediment can clog or abrade gill surfaces, disrupt normal feeding behavior, reduce feeding efficiency, and decrease food availability, reduce predator avoidance, or result in avoidance or displacement of fish from preferred habitat (Cordone and Kelley 1961, Phillips and Campbell 1961, Gregory 1993, Newcombe and Jensen 1996, Kemp et al. 2011). Salmonids have been observed to move laterally or downstream to avoid turbidity plumes, causing a disruption to their normal feeding or other behaviors (Sigler et al. 1984).

Temporary spikes in suspended sediment may result in behavioral avoidance of the action area by fish; several studies have documented active avoidance of turbid areas by juvenile and adult salmonids (e.g., Sigler et al. 1984, Lloyd 1987, Servizi and Martens 1992). Salmonids exposed to slight to moderate increases in turbidity have been shown to exhibit avoidance, loss of station in the stream, reduced feeding rates, and reduced use of overhead cover (Lloyd 1987). Short-term increases in turbidity and suspended sediment may disrupt feeding activities of fish or result in temporary displacement from preferred habitats. Juvenile salmonids are unlikely to avoid increased levels of turbidity below a level of 70 nephelometric turbidity units (NTU) (Bash et al. 2001). As a result, they may be at greater risk to turbidity and sediment-related effects than adults.

Increased turbidity, used as an indicator of increased suspended sediments, also is correlated with a decline in primary productivity, a decline in the abundance of periphyton (autotrophic and heterotrophic microorganisms), and reductions in the abundance and diversity of invertebrate fauna in the affected area (Lloyd 1987; Newcombe and MacDonald 1991). Increased sediment delivery can also fill interstitial substrate spaces and reduce cover for juvenile fish (Platts et. al. 1979) and abundance and availability of aquatic invertebrates for food (Bjornn and Reiser 1991).

Increases in turbidity associated with proposed instream work is likely to be temporary, localized plumes attenuating downstream as suspended sediment settles out of the water column. Potential effects of increased sedimentation and turbidity would be minimized through implementation of proposed BMPs including turbidity reduction measures, such as on-site turbidity monitoring, as well as stipulations included in the CWA Section 401 Water Quality Certification with the Central Valley RWQCB. Turbidity would be monitored and kept below limits established by the Central Valley RWQCB. Additional on-site turbidity monitoring will be conducted at the boat ramp site and 1,000 feet downstream such that if turbidity measured 1,000 feet downstream of the site exceeds double the measurement upstream of the site then work will stop and coordination between NMFS and USFS will occur to identify conditions that may be causing the high levels of turbidity. A silt curtain will be used at that time for in-water work to proceed.

Turbidity and sedimentation resulting from dredging is expected to be short term (i.e., 30 minutes to 4 hours per day), localized (i.e, 1.4 acres), and would rapidly attenuate with time and

distance from the point source as suspended sediment settles out in the water column. Baseline turbidity levels in the action area are typically highest in the winter and spring when maintenance activities are anticipated to occur thus subsequent turbidity impacts are expected to be well buffered at that time. The river channel is wide in the action area and the turbidity plume is not expected to extend across the channel.

Depending on the exact timing of implementation of the proposed action, migrating adult and juvenile and migrating and rearing juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead and all life stages of sDPS green sturgeon may be present in the action area when maintenance activities will be conducted. Water quality impacts are unlikely to affect migrating salmonid adults to the extent of injuring them as they are highly migratory and are expected to avoid the activity in the action area; however, degraded water quality may injure some salmonid juveniles, which are smaller, less mobile, and actively feed and grow nearshore, through the temporary disruption of normal behaviors that are essential to growth and survival that may result in an increase in predation, reduced feeding, and altered rearing, migrating, and sheltering behavior.

Although less is known about the timing of rearing and migration of sDPS green sturgeon, adult, larval, and juvenile life stages are known to utilize this section of the Sacramento River as a migration corridor and for rearing and spawning. Little is known about the specific detrimental physical and physiological effects of sedimentation and turbidity to green sturgeon. Green sturgeon are benthically oriented and their evolutionary biology with respect to morphology, physiology, sensory systems, and preferred diets allow for success near the benthos (Webb 1986, Kasumyan 1994, Kasumyan 1999, Kogut 2008). Their unique adaptations, such as electro-receptors and olfactory sense, allow for foraging in conditions where vision is limited or non-existent (Thomas et al. 2019) and suggests that green sturgeon are well adapted to turbid environments. Effects from increased turbidity are expected to be minimal for migrating and holding adult, migrating and rearing juvenile, and larval green sturgeon. Turbidity increases are expected to be minor in comparison to background levels, short in duration (i.e., 30 minutes to 4 hours), and to quickly dissipate and return to baseline conditions.

Spawning green sturgeon adults and egg life stages may be present in the action area and it is possible that suspended sediment from dredging activities may settle out on top of benthic areas where eggs may exist. However, green sturgeon spawn in deep pools (≥ 5 meters, e.g., Wyman et al. 2018) with high-velocity flows (Poytress et al. 2015) and turbidity plumes are expected to be brief (i.e., 30 minutes to 4 hours), relatively small and remain nearshore in shallow water, and not extend far downstream. Thus, it is unlikely that spawning adults and eggs will be present in the action area and effects are expected to minimal.

Avoidance and minimization measures, as well as BMPs, will minimize the extent and severity of turbidity- and sedimentation-related effects associated with the proposed action. However, it is expected that a low proportion of juvenile salmonids exposed to the area of increased turbidity are expected to be adversely affected by increased predation, reduced feeding, and an alteration in rearing, migrating, and sheltering behavior.

Contaminants and Pollution-related Effects

The proposed action would involve heavy construction equipment and activities that could impair water quality if a contaminant discharge were to occur. Potential sources of pollutants include fuel, lubricants, and hydraulic fluid. A leak or discharge could result in the introduction of heavy metals, nutrients, hydrocarbons, or synthetic compounds, which may cause increased temperatures, disease susceptibility, or algal blooming. Heavy equipment and machinery will be present in the action area, and metals may be deposited through their use and operation (Paul and Meyer 2008). Potential pollution-related effects have the potential to be persistent in the action area and may affect multiple life stages, if they were to occur.

High concentrations of contaminants have the potential to directly or indirectly affect SR winter run and CV spring-run Chinook salmon, CCV steelhead, and/or sDPS green sturgeon that may be migrating, rearing or spawning in the action area at the time of a pollution event or possibly afterwards. Potential effects include mortality from exposure, reduced oxygen availability, or increased susceptibility to disease that reduces the overall health and survival of the exposed fish. The severity of these effects depends on the contaminant, the concentration, duration of exposure, and sensitivity of the affected life stage. Contaminant materials from construction equipment have been shown to alter juvenile salmonid behavior through disruptions to various physiological mechanisms, including sensory disruption, endocrine disruption, neurological dysfunction, and metabolic disruption (Scott and Sloman 2004). Oil-based products used in combustion engines are known to contain polycyclic aromatic hydrocarbon (PAHs), which have been known to bio-accumulate in other fish taxa, such as flatfishes (order Pleuronectiformes) and have carcinogenic, mutagenic, and cytotoxic effects (Johnson et al. 2002). The exact toxicological effects of PAHs in juvenile salmonids are not well understood, although studies have shown that increased exposure of salmonids to PAHs reduces immunosuppression, increasing their susceptibility to pathogens (Arkoosh et al. 1998, Arkoosh and Collier 2002). A potential indirect effect of contamination is reduced prey availability (invertebrate prey survival could be reduced following exposure), making food less available for fish (Kidd et al. 2014). Fish consuming affected prey may also absorb toxins indirectly (Laetz et al. 2009).

Low numbers of listed fish species are expected to be present in the action area during maintenance activities and would likely be exposed if a pollution event occurred. Likelihood of potential exposure to contaminants throughout the lifetime of the project would be greatly minimized with proposed avoidance and minimization measures (listed in Section 1.3.2). Thus, impacts to Chinook salmon, steelhead, and green sturgeon from contaminants are not expected to occur.

Construction-related Disturbance

Construction-related disturbances in the action area will occur during ongoing maintenance activities including the placement of cobble or gravel and sediment removal (through mechanical removal methods) in the streambed. These activities have the potential to introduce short-term noise, vibration, and other physical disturbances into the immediate environment, and have the potential to affect salmonids and green sturgeon through displacement, disruption of their normal behaviors such as feeding, and injury or death from crushing during material placement or contact with heavy equipment.

Because in-water work could occur any time throughout the year, migrating adult and juvenile and rearing juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead and all life stages of sDPS green sturgeon could occur in the action area and be exposed to construction-related disturbances. Fish may exhibit movements that displace them from a position normally occupied in their habitat for short or long durations, which is of concern for juvenile fish as their innate behaviors are essential to their maturation and survival, such as feeding, sheltering, and migratory patterns. For juveniles, displacement from their rearing area and the need to relocate to a new rearing area may cause stress (Carlson et al. 2001). Displacement may additionally temporarily expose juvenile fish to a greater risk of predation. In the context of the proposed action area, behavior of migrating and rearing juvenile salmonids and green sturgeon may be affected by the various disturbances caused by maintenance activities.

Physical disturbances through contact with the excavator or from the placement of cobble/gravel could result in injury or mortality of listed species/life stages present in the action area. The excavator bucket and the track pads/bottom rollers would be the only heavy equipment that would enter the water. Adults and juveniles could potentially be crushed by falling cobble/gravel or debris and be hit or become trapped by equipment as work occurs, which could cause physical injury or death and/or an alteration of normal behavior. Juvenile fish are naturally attracted to boat ramps and feeding juveniles may be attracted to the dredging activity stirring up sediment (CDFW 2023b). Juvenile salmonids and green sturgeon are thus more likely to occur in the action area and be susceptible to injury or mortality.

Disturbance resulting from maintenance activities will be short-term (i.e. 30 minutes to 4 hours per occurrence) and infrequent (i.e., 1-3 occurrences per year) and physical disturbance will be localized around the area being dredged (0.02 acres) and area filled with cobble or gravel (0.001 acres), leaving the majority of the river channel unaffected or minimally affected by dredging activities. BMPs and avoidance and minimization measures will also be implemented to minimize the extent of construction-related effects in the action area. Such measures include gradually encouraging any fish present to move out of the dredging area and avoiding conducting maintenance activities from June 1 to October 31 of each year to minimize impacts to SR winter-run Chinook salmon adults migrating through the action area to reach spawning grounds as well as rearing green sturgeon juveniles in the action area. Additionally, maintenance activities will occur during daylight hours when juvenile and larval green sturgeon are less active and less likely to be in the action area. USFS will coordinate with the RBFWO and examine the project site prior to project implementation to ensure minimal presence of listed anadromous fish species.

Those fish that are exposed to the effects of maintenance activities will encounter short-term noise, vibrational, and physical disturbance impacts. Noise and vibrational disturbances are expected to be minor. Physical disturbances are expected to result in injury or harm by increasing the susceptibility of some juveniles to predation by temporarily disrupting normal behaviors and potentially crushing or killing juvenile anadromous fish. Subsequently, a low proportion of juvenile salmonids and green sturgeon are expected to experience direct injury or mortality through increased predation and contact with or entrapment by heavy equipment and/or falling cobble/gravel in the immediate area where dredging and filling of the scour hole will occur.

It is expected that adult salmonids and green sturgeon will avoid the shallow (1.5 - 3.0 feet), nearshore area where maintenance activities will occur and; therefore, are not expected to be present in the action area. Because green sturgeon spawning occurs in deep pools (≥ 5 meters, e.g., Wyman et al. 2018) and maintenance-related activities will occur nearshore in shallow water (1.5 – 3.0 feet), construction-related effects are not expected to impact spawning adults or eggs. The boat ramp where maintenance activities will occur is typically filled with sand, clay, fine particles, and aquatic vegetation and is a shallow, back-water, zero to low water velocity area. Because exogenous feeding larvae use the thalweg for higher velocity waters to re-distribute from hatching areas and appear to settle in areas with gravel and cobble substrates (RBFWO 2023), it is unlikely that larval green sturgeon will be present at the boat ramp where dredging activities and cobble/gravel placement will occur. Thus, maintenance-related effects from physical disturbances are not expected to impact larval green sturgeon.

2.5.2. Effects of the Proposed Action to Critical Habitat and PBFs

Maintenance activities are expected to have short-term effects on habitat quantity and quality, including effects on the PBFs of designated critical habitat of listed species. The PBFs that occur within the action area for SR winter-run Chinook salmon are (1) migratory corridors for both upstream and downstream migration, (2) habitat and prey items that are free of contaminants, (3) adequate river flows for downstream transport of juveniles, and (4) riparian habitat for juvenile rearing. The PBFs within the action area for sDPS green sturgeon are: (1) food resources, (2) adequate flow regime for all life stages, (3) water quality, (4) migratory corridors, (5) adequate water depth for all life stages, and (6) adequate sediment quality, and (7) suitable substrate type or size. The PBFs within the action area for CV spring-run Chinook salmon and CCV steelhead are (1) freshwater rearing sites, and (2) freshwater migration corridors. There is potential for degradation of PBFs resulting from turbidity and sedimentation or incursion of contaminants during the action.

Contaminants and Pollution-related Effects

Heavy power equipment, such as an excavator, could potentially impair water quality should hazardous materials enter the Sacramento River. A release of hazardous materials, such as fuel or oil, could have negative effects on listed fish species and critical habitat (Feist et al. 2011) including impacts to water quality, prey resources, and freshwater migratory corridor and rearing habitat PBFs. The included BMPs and avoidance and minimization measures for the project are expected to avoid the potential for exposure to hazardous materials. Therefore, the potential effects from hazardous materials entering the aquatic environment and adversely impacting designated critical habitat for all four listed fish species are not expected to occur.

Dredging of sediment can resuspend any contaminants in the dredged sediment, with potential negative impacts to water quality, prey resources, and rearing habitat PBFs. For example, exposure to contaminated food sources and bioaccumulation of contaminants from feeding on them (i.e. contaminants such as organochlorines that biomagnify in aquatic food webs and present a greater risk to higher trophic level fish) may create delayed sublethal effects that negatively affect the growth, reproductive development, and reproductive success of listed anadromous fishes, thereby reducing their overall fitness and survival (Laetz et al. 2009). Green

sturgeon are expected to be more vulnerable than salmonids to sediment contamination due to their benthic-oriented behavior, which conceivably put them in closer proximity to the contaminated sediment horizon (Presser and Luoma 2010, 2013). Sturgeon are also benthic invertebrate feeders that forage on organisms, such as Asian clams, that can sequester contaminants at much higher levels than the ambient water or sediment content (CDFG 2002, Linville et al. 2002). Because the dredge materials in this case are composed of sediment deposits from seasonal Sacramento River flow events that experience high turnover, no known contamination is anticipated. Thus, contaminant-related adverse impacts to designated critical habitat for all four listed fish species are not expected to occur.

Sedimentation and Turbidity-related Effects

Increases in turbidity and sedimentation will occur as a result of annual sediment removal and cobble/gravel input at the boat ramp which may impact critical habitat PBFs including food resources, substrate type or size, water flow, migratory corridor, sediment quality, water depth, rearing habitat, and water quality.

There is potential for degradation of PBFs resulting from turbidity and sedimentation. The deposition of sediment is expected to temporarily reduce food resources due to the influx and deposition of suspended sediment on the pre-existing substrate. Short-term increases in turbidity and suspended sediment levels associated with maintenance activities may negatively impact rearing habitat PBFs temporarily through reduced availability of food as well as altered feeding behavior as a result of avoidance or displacement from preferred habitat. Short-term increases in turbidity and suspended sediment levels may also temporarily impact water quality as elevated levels have been shown to have physiochemical effects to lotic aquatic systems including reduced oxygen supply (Kemp et al. 2011). Effects to migratory corridor PBFs for listed species include the temporary turbidity plume nearshore and downstream but, given the width of the river, migration of adult listed species through this area are not expected to alter course or behavior. Juveniles migrating downstream may avoid the disturbance and move into deeper water, which could result in higher risk of predation. As the turbidity plum is expected to be relatively small (i.e., 1.4 acres) and short-term (i.e., 30 minutes to 4 hours), the increased risk is expected to be small.

With the implementation of BMPs and minimization and avoidance measures, the amounts and levels of turbidity and sedimentation levels resulting from maintenance activities will be small and low, respectively, relative to the overall sediment load on the Sacramento River due to the size and temporary nature of the project. The turbidity plume is expected to remain nearshore along the river margin and would not extend across the channel. Because turbidity and sedimentation-related effects will be localized, impacts to critical habitat PBFs will be limited to the immediate area on or near the boat ramp where turbidity and sedimentation levels are expected to be highest. Subsequently, it is expected that effects to critical habitat PBFs (food resources, migratory corridor for juveniles, and rearing habitat) will likely impact migrating and rearing juvenile life stages of salmonids and green sturgeon.

Due to the intermittent and relatively small-scale nature of the proposed project, turbidity and sedimentation-related effects to adequate flow, water depth, sediment quality, suitable substrate

type and size, and adult migratory PBFs for all listed species are expected to be minimal. Potential adverse effects to critical habitat PBFs for the species addressed in this biological opinion resulting from sedimentation and turbidity are not expected to occur at a scale in which critical habitat would be permanently impacted. With the minimization and avoidance measures included in the proposed action, turbidity and sedimentation are expected to result in short-term, localized disturbances to critical habitat PBFs in the action area and is not expected to cause any long-term impacts to habitat.

Beneficial Effects

The ongoing deposition of cobble or gravel to fill the scour hole that exists at the end of the boat ramp is expected to improve suitable substrate PBFs for spawning and egg life stages of green sturgeon, as the gravel/cobble will likely be washed downstream during high flow events and subsequently augment habitat with suitable substrate for spawning and egg life stages.

2.6. Cumulative Effects

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

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

2.6.1. Water Diversions

Water diversions for municipal and industrial use are found near the action area. Depending on the size, location, and season of operation, these unscreened diversions entrain and kill many life stages of aquatic species, including juvenile listed anadromous species.

2.6.2. Increased Urbanization

Increases in urbanization and housing developments can impact habitat by altering watershed characteristics and changing both water use and stormwater runoff patterns. Increased growth will place additional burdens on resource allocations, including natural gas, electricity, and water, as well as on infrastructure, such as wastewater sanitation plants, roads and highways, and public utilities. Some of these actions, particularly those which are situated away from water bodies, 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 near the action area. Among the activities expected to increase in volume and frequency is recreational boating. Boating activities typically result in increased wave action and propeller wash in waterways. This potentially will degrade riparian and wetland habitat by eroding channel banks and mid-channel islands, thereby causing an increase in siltation and turbidity. Wakes and propeller wash also churn up benthic sediments thereby potentially re-suspending contaminated sediments and degrading areas of submerged vegetation. This 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. Recreational boating can also be a vector for the introduction of harmful aquatic invasive species (AIS) when recreational boaters inadvertently transport AIS that become caught in propellers or intakes or attached to hulls (e.g., De Ventura et al. 2016, Johnson et al. 2001). AIS can outcompete native species for limited resources, permanently alter and degrade native habitats, and impair ecosystem functions which can subsequently negatively impact listed fish species and their critical habitat. Once AIS become established, AIS can expand rapidly, making it difficult and often not feasible to control and eradicate populations (Cole et al. 2019).

2.6.3. Rock Revetment and Levee Repair Projects

Cumulative effects include non-Federal riprap projects. Depending on the scope of the action, some non-Federal riprap projects carried out by state or local agencies do not require Federal permits. These types of actions and illegal placement of riprap occur within the Sacramento River watershed. The effects of such actions result in continued degradation and fragmentation of riparian and freshwater habitat and the conversion of complex, dynamic nearshore aquatic habitats to simplified habitats with impaired ecosystem functioning.

2.6.4. Aquaculture and Fish Hatcheries

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

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

Impacts of hatchery fish can occur in both freshwater and the marine ecosystems. Limited marine carrying capacity has implications for naturally produced fish experiencing competition with hatchery production. Increased salmonid abundance in the marine environment may also decrease growth and size at maturity, and reduce fecundity, egg size, age at maturity, and survival (Bigler et al. 1996).

2.6.5. Recreational Fishing

While hatchery CCV steelhead and Chinook salmon are targeted, incidental catch of protected species, such as naturally produced CV spring-run Chinook salmon and CCV steelhead, does occur. Since 1998, all hatchery CCV steelhead have been marked with an adipose fin clip, allowing anglers to tell the difference between hatchery and wild CCV steelhead. Current regulations restrict anglers from keeping unmarked CCV steelhead in Central Valley streams, except in the upper Sacramento River.

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

In addition, survival of CCV steelhead eggs is reduced by anglers walking on redds in spawning areas while targeting hatchery CCV steelhead or salmon. Roberts and White (1992) identified up to 43 percent mortality from a single wading over developing trout eggs, and up to 96 percent mortality from twice daily wading over developing trout eggs. Salmon and trout eggs are sensitive to mechanical shock at all times during development (Leitritz and Lewis 1980). While state angling regulations have moved towards restrictions on selected sport fishing to protect listed fish species, hook and release mortality of steelhead and trampling of redds by wading anglers may continue to cause a threat.

2.6.6. Habitat Restoration

Voluntary state or private sponsored habitat restoration projects may have short-term negative effects associated with in-water construction work, but these effects typically are temporary, localized, and the overall outcome is expected to benefit listed species and habitats.

2.6.7. Agricultural Practices

Non-Federal actions that may affect the action area include ongoing agricultural activities in the Sacramento River watershed. Farming and ranching activities within or adjacent to or upstream of the action area may have negative effects on water quality due to runoff laden with agricultural chemicals. Stormwater and irrigation discharges related to agricultural activities

contain numerous pesticides and herbicides that may adversely affect salmonid reproductive success and survival rates (King et al. 2014). 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. Agricultural practices in the Sacramento River may adversely affect riparian and wetland habitats through upland modifications of the watershed that lead to increased siltation or reductions in water flow.

2.6.8. Mining Activities

Increased water turbidity levels for prolonged periods of time may result from adjacent active mining activities (i.e., quarries and streambed or gravel bar skimming and pitting), and increased urbanization and/or development of riparian habitat, and could adversely affect the ability of young salmonids to feed effectively, resulting in reduced growth and survival. Turbidity may cause harm, injury, or mortality to juvenile anadromous fish in the vicinity and downstream of the project area. High turbidity levels can reduce the ability of listed fish to feed and respire, resulting in increased stress levels and reduced growth rates, and reduce tolerance to fish diseases and toxicants. Mining activities may adversely affect water quality, riparian function, and stream productivity.

2.7. Integration and Synthesis

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

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

SR winter-run Chinook salmon ESU, CV spring-run Chinook salmon ESU, CCV steelhead DPS, and sDPS North American green sturgeon have experienced significant declines in abundance and available habitat in the California Central Valley over the last century relative to historical conditions. The status of the species (Section 2.2) details the current range-wide status of these ESUs and DPSs and their critical habitat. Factors that led to the current listing of these listed fish species under the ESA include past and present human activities, drought, hatchery influence, dam construction, and habitat limitation and degradation that have been identified as influential to the survival and recovery of the listed species. Beyond the continuation of the human activities affecting the species, we also expect that ocean condition cycles and climatic shifts will continue to have both positive and negative effects on the species' ability to survive and recover.

The current status of listed anadromous fish species has not significantly improved since the species' previous status reviews (NMFS 2015, 2016a, 2016b, 2016c, SWFSC 2022) and, in some cases, has declined further. The SR winter-run Chinook salmon ESU is constrained to a single

population and a concentrated spawning area, which are both susceptible to drought and fluctuating temperatures. The CV spring-run Chinook salmon ESU and CCV steelhead DPS are constrained by small population sizes and altered habitat that is susceptible to climate change. If measures are not taken to reverse these trends, the recovery and survival potential of SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead will continue to worsen. The viability of sDPS green sturgeon is constrained by factors, such as a small population size, lack of multiple populations, and concentration of spawning sites into just a few locations. Although threats due to habitat alteration are thought to be high and indirect evidence suggests a decline in abundance, there is much uncertainty regarding the scope of threats and the viability of population abundance indices (NMFS 2018). The critical habitat for all listed fish species is degraded from their historical conditions, but are still considered critically important to the recovery and conservation of the species for which they were designated.

2.7.2. Summary of the Environmental Baseline and Cumulative Effects

The environmental baseline (Section 2.4) describes the current baseline conditions found in the Sacramento River, where the proposed action is to occur. Factors affecting the listed species in the action area include barriers limiting habitat, predation, water quality and temperature management, and urbanization. Section 2.4.4 discusses the vulnerability of listed species and critical habitat to climate change projections in the California Central Valley and specifically in the Sacramento River. Reduced summer flows and increased water temperatures will likely be exacerbated by increasing surface temperatures in the Sacramento River. The Sacramento River is a highly manipulated system with flow and temperature regimes that differ drastically from their historical condition. The cumulative effects from continuing activities described in Section 2.6 are expected to continually negatively affect the federally listed anadromous fish species and further diminish the functional value of critical habitat for the conservation of the species within the action area through various pathways including, but not limited to, decreased water flow and quality, increases in water temperatures, levee construction and bank protection, increased stormwater and agricultural runoff, increased river traffic, riparian habitat degradation and fragmentation.

2.7.3. Summary of Effects of the Proposed Action to Listed Species

While maintenance activities will primarily occur during the January 1 to May 31 in-water work window, it is possible that maintenance activities will be conducted outside of this timeframe and throughout the year for emergency purposes. For these reasons, effects of the proposed action have been analyzed in correspondence to the listed fish species and life stages that may be present in the action area during the year. Additionally, the in-water work window does not preclude SR winter-run Chinook salmon and green sturgeon presence in the action area, but identifies a time frame when SR winter-run Chinook salmon and green sturgeon are minimally present in the action area and to avoid the most sensitive life stages to the greatest extent possible as well as peak migrations.

The proposed action is expected to affect juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, and juvenile sDPS green sturgeon. The project is expected to result in the harm, injury or death and predation-related mortality of individuals from the

temporary increase in suspended sediment and turbidity, reduction in rearing habitat, and maintenance-related disturbances.

Turbidity changes that are within the Central Valley RWQCB standards would result in sudden localized turbidity increases that would injure juvenile salmonids by temporarily impairing their migration, rearing, feeding, or sheltering behavior. Dredging-related turbidity and sedimentation increases would also contribute to the susceptibility of juvenile salmonids to increased predation. Turbidity- and sedimentation-related injury and predation will be minimized by implementing BMPs and avoidance and minimization measures including turbidity monitoring, coordinating with the RBFWO and scheduling in-water work to avoid peak migrations and sensitive life stages, and examining the project site prior to project implementation to ensure minimal presence of listed anadromous fish species.

Maintenance-related physical disturbances are also expected to result in adverse effects to juvenile salmonids sturgeon as a result of heavy equipment operation in the river. Individuals that are exposed to the effects of maintenance activities will encounter short-term (i.e., 30 minutes to 4 hours) physical disturbance impacts that are expected to result in injury or mortality through increased predation by temporary disruption of normal behaviors and contact with or entrapment by heavy equipment and/or falling cobble/gravel in the immediate area where dredging and filling of the scour hole will occur. Noise and vibrational disturbances are expected to be minor, intermittent, and temporary. Additionally, adverse effects due to contaminants and pollution are expected to be avoided given the BMPs and avoidance and minimization measures that will be implemented.

2.7.4. Summary of Effects of the Proposed Action to Critical Habitat

Critical habitat has been designated in the action area for all four listed species and PBFs affected for each species are described in section 2.5.2.

Annual dredging activities and cobble/gravel input in the action area would result in short-term increases in turbidity and sedimentation, which are expected to impact food resources, migratory corridor for juveniles, and rearing habitat PBFs for all four species. These effects to critical habitat PBFs would be temporary, infrequent, localized, and minimized with the implementation of proposed avoidance and minimization measures and BMPs. Adverse effects to critical habitat PBFs for the species addressed in this opinion resulting from turbidity and sedimentation are not expected to be long-term, nor will they occur at a scale in which critical habitat will be permanently impacted.

The included BMPs and avoidance and minimization measures for the project are expected to avoid exposure to hazardous materials. Therefore, effects from hazardous materials entering the aquatic environment and adversely impacting designated critical habitat for all four listed fish species are not expected to occur.

The ongoing deposition of cobble or gravel to fill the scour hole that exists at the end of the boat ramp is expected to provide suitable substrate PBFs for green sturgeon, as the gravel/cobble will likely wash downstream during high flow events and subsequently augment habitat with substrate that benefits green sturgeon spawning, larval, and egg life stages.

2.7.5. Risk to Listed ESUs/DPSs and Critical Habitat at the Designation Level

The Sacramento River contains spawning populations of SR winter-run and CV spring-run Chinook salmon, CCV steelhead, and sDPS green sturgeon, making it an important river in terms of range-wide recovery for these species. Furthermore, the Sacramento River is the primary spawning location for SR winter-run Chinook salmon, with confirmed SR winter-run Chinook salmon spawning and juvenile production in Battle Creek since 2020 as a result of introduction efforts. The Sacramento River is also one of the few known spawning locations for sDPS green sturgeon.

While maintenance activities are expected to cause adverse effects to a small proportion of each of the listed species, the impacts will be relatively short in duration (i.e., 30 minutes to 4 hours per occurrence), infrequent (1-3 occurrences per year), and will avoid higher river levels and peak migration time periods, so that abundance will be low within the project footprint. Specific avoidance and minimization measures (e.g., coordinating with RBFWO) are also in place to ensure minimal presence of anadromous listed fish and the most sensitive non-migratory life stages (i.e., spawning, egg incubation, larvae). Additionally, several effects identified are minimal or minor in nature, not lethal. Maintenance-related impacts will be temporary and will not impede migrating adult fish from reaching spawning and holding habitat, or juvenile fish from migrating downstream, or sDPS green sturgeon spawning, and will not permanently modify critical habitat function. Overall, the number of fish present in the action area is not expected to represent a substantial proportion of the population present in the system; thus, project impacts are not expected to affect the other populations of the ESUs or DPSs within the Sacramento River of SR winter-run Chinook salmon ESU, CV spring-run Chinook salmon ESU, CCV steelhead DPS, and green sturgeon DPS populations and will not negatively affect their viability.

Combining the adverse and beneficial effects (input of cobble or gravel) associated with the proposed action described above, including the environmental baseline, cumulative effects, status of the species, and critical habitat, the project is not expected to reduce appreciably the likelihood of both the survival and recovery of the listed species in the wild by reducing their numbers, reproduction, or distribution; or appreciably diminish the value of designated critical habitat for the conservation of the species.

2.8. Conclusion

After reviewing and analyzing the current status of the listed species and critical habitat, the environmental baseline within the action area, the effects of the proposed action, the effects of other activities caused by the proposed action, and the cumulative effects, it is NMFS' biological opinion that the proposed action is not likely to jeopardize the continued existence of SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or 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). "Harass" is further defined by interim guidance as to "create the likelihood of injury to wildlife by annoying it to such an extent as to significantly disrupt normal behavioral patterns which include, but are not limited to, breeding, feeding, or sheltering." "Incidental take" is defined by regulation as takings that result from, but are not the purpose of, carrying out an otherwise lawful activity conducted by the Federal agency or applicant (50 CFR 402.02). Section 7(b)(4) and section 7(o)(2) provide that taking that is incidental to an otherwise lawful agency action is not considered to be prohibited taking under the ESA if that action is performed in compliance with the terms and conditions of this ITS.

2.9.1. Amount or Extent of Take

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

NMFS anticipates incidental take of juvenile SR winter-run Chinook salmon, juvenile CV spring-run Chinook salmon, juvenile CCV steelhead, and juvenile sDPS green sturgeon in the form of harassment, harm, injury or mortality as a result of project implementation. Adverse effects are expected due to sedimentation and turbidity increases and maintenance-related disturbances.

NMFS cannot precisely quantify and track the amount or number of individuals per species that are expected to be taken incidentally as a result of the proposed project. This is due to the variability and uncertainty associated with the response of listed species to the effects of the proposed action, the varying population size of each species, annual variations in the timing of migration, individual habitat use within the action area, and difficulty in observing injured or dead fishes. However, it is possible to estimate the extent of incidental take by designating, as ecological surrogates, those elements of the project that are expected to result in incidental take. Ecological surrogates are more predictable and/or measurable, and monitoring those surrogates will determine the extent to which incidental take is occurring. The most appropriate thresholds for incidental take are ecological surrogates of temporary habitat disturbance during in-water maintenance activities.

NMFS anticipates incidental take will be limited to the following forms:

1) Take in the form of harm and harassment resulting from habitat-related disturbances during dredging and cobble/gravel placement, resulting in increases to ambient background levels of turbidity in the aquatic environment downstream of the project site. Based on the type of equipment used and the methods described for maintenance, the increases in turbidity above ambient background conditions are not expected to extend beyond a 1.4-acre area (i.e., turbidity plume), measuring 100 feet from the bank and 350 feet downstream. Increases in turbidity are reasonably certain to result in harm and harassment to juvenile SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead through increased predation, reduced feeding, and an alteration in

rearing, migrating, and sheltering behavior. Increases in turbidity are reasonably certain to result in harm and harassment to all four species through temporary modification or degradation of food resources, migratory corridor for juveniles, and rearing habitat PBFs leading to temporary displacement of individuals, reduced feeding, and increased predation, decreasing fitness and survival. If the total acreage of the turbidity area for the project exceeds 1.4 acres by more than 10 percent (0.14 acres), then anticipated take levels described are also exceeded, triggering the need to reinitiate consultation. Due to the short-term and infrequent nature of the action, actual numbers for all four species is expected to be low. Actual numbers for green sturgeon are expected to be less than SR winter-run Chinook salmon, CV spring-run Chinook salmon, and CCV steelhead.

2) Take in the form of harm, harassment, injury and death to listed fish during dredging and placement of cobble/gravel to fill the scour hole, covering 0.021 acres in the streambed at the end of the boat ramp. These disturbances will affect the behavior of listed fish, resulting in displacement, increased predation, and decreased feeding. In turn, these will result in decreased survival, reduced growth, and reduced fitness. Fish present and unable to avoid the activities and heavy equipment would be crushed, killed, or trapped. If the total acreage of the dredging and cobble/gravel placement area for the project exceeds 0.021 acres by more than 10 percent (0.0021 acres), then anticipated take levels described are also exceeded, triggering the need to reinitiate consultation. Due to the short-term and infrequent nature of the action and size of the project site, actual numbers for all four species is expected to be low.

2.9.2. Effect of the Take

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

2.9.3. Reasonable and Prudent Measures

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

1. Measures shall be taken by USFS, including any and all individuals and/or employees contracted to carry out the work, to ensure the implementation of the project as proposed in this opinion, as well as implementation and adherence to best management practices and conservation measures.

2. Measures shall be taken by USFS, including any and all individuals and/or employees contracted to carry out the work, to minimize sedimentation events and turbidity plumes in the action areas and related adverse effects to listed species and their critical habitat.

3. Measures shall be taken by USFS, including any and all individuals and/or employees contracted to carry out the work, to minimize adverse effects during implementation of maintenance activities.

4. Measures shall be taken by USFS, including any and all individuals and/or employees contracted to carry out the work, to monitor and report on project activities and amount and extent of incidental take of listed species during project activities in the action area.

2.9.4. Terms and Conditions

In order to be exempt from the prohibitions of section 9 of the ESA, the Federal action agency must comply (or must ensure that any applicant complies) with the following terms and conditions. The USFS 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. USFS shall take all reasonable precautions to prevent heavy equipment from entering the water (with the exception of the excavator bucket and partial submergence of excavator track pads and bottom rollers).

    b. USFS proposes to primarily conduct in-water maintenance activities between January 1 and May 31 of each year (the exception being conducting maintenance outside of this time frame for emergency purposes). It is expected that sDPS green sturgeon migrating and spawning adults, as well as larvae, will be present in the system during the January 1 – May 31 in-water work window. USFS shall coordinate activities with the RBFWO to carry out the proposed action to avoid the presence of these life stages or to minimize it to when presence is lowest in the action area. If it is determined that these green sturgeon life stages are present when maintenance activities will be conducted:
        i. A qualified USFS fisheries biologist shall actively monitor the action area (up to 400 feet downstream) for green sturgeon presence, including life stages potentially present at that time.
        ii. If green sturgeon are observed in the action area, the life stages present, abundances, and areas of occurrence shall be documented, NMFS shall be notified by email, and maintenance activities shall be halted until additional measures can be implemented to avoid project effects.

    c. In-water maintenance activities shall be avoided between June 1 to October 31 of each year, except for emergency maintenance, to minimize impacts to SR winter-run Chinook salmon adults migrating through the action area to reach spawning grounds, as well as rearing green sturgeon juveniles. If in-water maintenance activities will occur between June 1 to October 31, USFS shall coordinate activities with the RBFWO to carry out the proposed action when presence is lowest in the action area. Additionally:
        i. A qualified USFS fisheries biologist shall actively monitor the action area (up to 400 feet downstream) for SR winter-run Chinook salmon

and green sturgeon presence, including life stages potentially present at that time.

ii. If SR winter-run Chinook salmon or green sturgeon are observed in the action area, life stages present, abundances, and areas of occurrence will be documented, NMFS shall be notified by email, and maintenance activities will be halted until additional measures can be implemented to avoid project effects.

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

    a. Turbidity monitoring shall occur at the active project site and no further than 1,000 feet downstream of the active project site, at a depth approximately two thirds of the total water depth. Turbidity measurements shall be taken twice daily during maintenance activities.

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

    a. If listed anadromous fish species, salmonid redds, and green sturgeon eggs are found upon initial examination of the project site, 5 calendar days prior to when maintenance activities are expected to occur, a qualified USFS fisheries biologist shall determine if additional avoidance or minimization measures need to be implemented to minimize adverse impacts to listed fish species. The fisheries biologist shall additionally document the presence of listed fish species, including dates, life stages present, abundances, and areas of occurrence, and include these details in the annual report under Term and Condition 4(a)(i) and 4(a)(ii).

    b. All in-water work shall be monitored by a qualified USFS fisheries biologist who will be on site while maintenance activities are conducted. The USFS fisheries biologist shall monitor the active project site before and during project activities to minimize listed species presence, as well as the whole action area (up to 400 feet downstream).

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

    a. USFS shall provide an annual report to NMFS that will be due by November 30 of each year. The report shall include:
        i. Description of any observations or incidental take of species that occurs as part of project activities including fish known to have been killed or injured during project activities, fish species and life stages affected, amount, and area found.
        ii. Summary of in-water maintenance dates and activities, amount of material dredged, the extent of the dredged area, amount of material deposited in scour hole, avoidance and minimization measures taken, if and when emergency maintenance was conducted and purpose, and turbidity monitoring sites, schedule and measurements.

b. Any SR winter-run Chinook salmon, CV spring-run Chinook salmon, CCV steelhead, or sDPS green sturgeon found dead or injured within the action area during maintenance activities shall be reported within 48 hours to NMFS via email (see email address below in 4(c)). Any dead specimen(s) shall be placed in a cooler with ice and held for pick up by an individual designated to do so.

c. All reports for NMFS shall be sent by email to:

Assistant Regional Administrator
National Marine Fisheries Service
California Central Valley Office
Email: ccvo.consultationrequests@noaa.gov

2.10. Conservation Recommendations

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

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

2) USFS should post interpretative signage within the boat ramp area to inform boat users of the endangered and threatened salmon, steelhead, and sturgeon and their critical habitat that occur within the Sacramento River and actions that they can take to help and/or prevent further harm to those species.

3) USFS 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).

4) USFS should test the dredged sediment for contaminants after each maintenance event to determine if contaminants exist in the dredged sediment and at what levels and to ensure contaminants are not being released from dredging activities.

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

2.11. Reinitiation of Consultation

This concludes formal consultation for the Sycamore Grove Boat Launch Maintenance Project.

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

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

Section 305(b) of the MSA directs Federal agencies to consult with NMFS on all actions or proposed actions that may adversely affect EFH. Under the MSA, this consultation is intended to promote the conservation of EFH as necessary to support sustainable fisheries and the managed species' contribution to a healthy ecosystem. For the purposes of the MSA, EFH means "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity", and includes the physical, biological, and chemical properties that are used by fish (50 CFR 600.10). Adverse effect means any impact that reduces quality or quantity of EFH, and may include 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 USFS and descriptions of EFH for Pacific Coast salmon (PFMC 2014) contained in the fishery management plans developed by the PFMC and approved by the Secretary of Commerce.

3.1. Essential Fish Habitat Affected by the Project

EFH is designated under the Pacific Coast Salmon FMP, which includes the action area of the proposed action. EFH in the action area consists of adult migration habitat and juvenile rearing and migration habitat for the four Chinook salmon runs (winter-, spring-, fall-, and late fall-run Chinook salmon). Habitat areas of particular concern (HAPCs) that may be either directly or indirectly adversely affected include (1) complex channels and floodplain habitats. The other HAPCs for Pacific Coast Salmon, (2) thermal refugia, (3) spawning habitat, (4) estuaries, and (5) marine and estuarine submerged aquatic vegetation, are not present in the action area.

3.2. Adverse Effects on Essential Fish Habitat

The potential effects of the proposed action on EFH for Pacific Coast salmon include short-term effects associated with dredging activities. Effects to Pacific Coast salmon HAPCs for (1) complex channel and floodplain habitat are discussed in the context of effects to critical habitat PBFs as designated under the ESA and described in section 2.5.2. A list of adverse effects to EFH HAPCs is included in this EFH consultation. The effects are expected to be similar to the temporary impacts affecting critical habitat and include the following: sediment and turbidity, in-channel disturbance, and contaminant incursion.

Sediment and turbidity

- Degraded water quality
- Reduction/change in aquatic macroinvertebrate production

In-channel disturbance from dredging

- Channel disturbance from dredging activity
- Reduction/change in aquatic macroinvertebrate production

Contaminants and Pollution-related Effects

- Degraded water quality
- Reduction in aquatic macroinvertebrate production

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) To address the adverse effects of sediment and turbidity for (1) complex channel and floodplain habitat, NMFS recommends implementation of Section 2.9.4, Terms and Conditions 2(a).

2) To address the adverse effects from in-channel disturbance from dredging for (1) complex channel and floodplain habitat, NMFS recommends implementation of Section 2.9.4, Terms and Conditions 1(a).

3) To address the adverse contaminants and pollution-related effects for (1) complex channel and floodplain habitat, NMFS recommends:
    a. Implementation of Section 2.9.4, Terms and Conditions 1(a)
    b. Use of biodegradable lubricants and hydraulic fluid in construction machinery. The use of petroleum alternatives can greatly reduce the risk of contaminants from entering the aquatic ecosystem.

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 Requirement

As required by section 305(b)(4)(B) of the MSA, USFS 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 USFS must reinitiate EFH consultation with NMFS if the proposed action is substantially revised in a way that may adversely affect EFH, or if new information becomes available that affects the basis for NMFS' EFH Conservation Recommendations [50 CFR 600.920(l)].

4. Data Quality Act Documentation and Pre-Dissemination Review

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

4.1. Utility

Utility principally refers to ensuring that the information contained in this consultation is helpful, serviceable, and beneficial to the intended users. The intended users of this opinion are the U.S. Forest Service. Other interested users could include the U.S. Fish and Wildlife Service or California Department of Fish and Wildlife. Individual copies of this opinion were provided to the U.S. Forest Service. The document will be available within 2 weeks at the NOAA Library Institutional Repository (https://repository.library.noaa.gov/welcome). The format and naming adhere to conventional standards for style.

4.2. Integrity

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

4.3. Objectivity

Information Product Category: Natural Resource Plan

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

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

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

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

5. REFERENCES

Anderson, N. H. and J. R. Sedell. 1979. Detritus Processing by Macroinvertebrates in Stream Ecosystems. Annual Review of Entomology 24(1):27.

Arkoosh, M. R., E. Casillas, E. Clemons, A. N. Kagley, R. Olson, P. Reno, and J. E. Stein. 1998. Effect of Pollution on Fish Diseases: Potential Impacts on Salmonid Populations. Journal of Aquatic Animal Health 10(2):182-190.

Arkoosh, M. and T. Collier. 2002. Ecological Risk Assessment Paradigm for Salmon: Analyzing Immune Function to Evaluate Risk. Human and Ecological Risk Assessment 8(2):265-276.

Bash, J., C. Berman, and S. Bolton. 2001. Effects of Turbidity and Suspended Solids on Salmonids. University of Washington, Center for Streamside Studies. Prepared for Washington State Transportation Commission.

Beechie, T., H. Imaki, J. Greene, A Wade, H. Wu, G. Pess, P. Roni, J. Kimball, J. Standford, P. Kiffney, and N. Mantua. 2012. Restoring Salmon Habitat for a changing climate. River Research and Applications. 22 pages.

Bigler, B.S., D.W. Wilch and J.H. Helle. 1996. A review of size trends among North Pacific salmon (*Oncorhynchus spp.*). Canadian Journal of Fisheries and Aquatic Sciences. 53:455-465.

Billington, D. P., D. C. Jackson, and M. V. Melosi. 2005. The History of Large Federal Dams: Planning, Design, and Construction. Government Printing Office.

Bjornn, T.C. and D.W. Reiser. 1991. Habitat requirements of anadromous salmonids. In W. R. Meehan (editor), Influences of forest and rangeland management on salmonid fishes and their habitats, pages 83-138. American Fisheries Society Special Publication 19. American Fisheries Society, Bethesda, MD.

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

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

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

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

California Department of Fish and Wildlife (CDFW). 2022. GrandTab 2022.07.20 California Central Valley Chinook Escapement Database Report. 27 pages. Accessed January 23, 2023.

California Department of Fish and Wildlife (CDFW). 2023a. Recreational Ocean, In-River Salmon Fisheries In California To Close For Remainder Of 2023. News Release May 19, 2023. Available: https://wildlife.ca.gov/News/Archive/recreational-ocean-in-river-salmon-fisheries-in-california-to-close-for-remainder-of-2023#gsc.tab=0

California Department of Fish and Wildlife (CDFW). 2023b. Doug Killam. Senior Environmental Scientist, CDFW. Personal communication on June 2, 2023.

Carlson, T. J., G. R. Ploskey, R. L. Johnson, R. P. Mueller, M. A. Weiland, and P. N. Johnson. 2001. Observations of the Behavior and Distribution of Fish in Relation to the Columbia River Navigation Channel and Channel Maintenance Activities. PNNL-13595; Other: 400403209 United States 10.2172/965655 Other: 400403209 PNNL English, Pacific Northwest National Lab. (PNNL), Richland, WA (United States).

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

Cole, E., Keller, R.P. and Garbach, K. 2019. Risk of invasive species spread by recreational boaters remains high despite widespread adoption of conservation behaviors. Journal of Environmental Management, 229, pp.112-119.

Cordone, A. J. and D. W. Kelley. 1961. The Influences of Inorganic Sediment on the Aquatic Life of Streams. California Fish and Game 47(2):189-228.

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

Dettinger, M.D., D.R. Cayan, M.K. Meyer and A.E. Jeton. 2004. Simulated Hydrologic Responses to Climate Variations and Changes in the Merced, Carson, and American River Basins, Sierra Nevada, California, 1900-2099. Climatic Change 62(62):283-317.

Dettinger, M.D. 2005. From Climate Change Spaghetti to Climate-Change Distributions for 21st Century California. San Francisco Estuary and Watershed Science 3(1):1-14.

De Ventura, L., Weissert, N., Tobias, R. et al. 2016. Overland transport of recreational boats as a spreading vector of zebra mussel *Dreissena polymorpha*. Biol Invasions 18, 1451–1466. https://doi.org/10.1007/s10530-016-1094-5

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

Domagalski, J. L., D. L. Knifong, P. D. Dileanis, L. R. Brown, J. T. May, V. Connor, and C. N. Alpers. 2000. Water Quality in the Sacramento River Basin, California, 1994–1998. U.S. Geological Survey Circular 1215.

Dosskey, M. G., P. Vidon, N. P. Gurwick, C. J. Allan, T. P. Duval, and R. Lowrance. 2010. The Role of Riparian Vegetation in Protecting and Improving Chemical Water Quality in Streams. Journal of the American Water Resources Association (JAWRA) 46(2):261-277. DOI: 10.1111/j.1752-1688.2010.00419.x

DuBois, J. and A. Danos. 2018. 2017 Sturgeon Fishing Report Card: Preliminary Data Report. California Department of Fish and Wildlife, Bay Delta Region (Stockton).

Feist, B.E., Buhle, E.R., Arnold, P., Davis, J.W. and Scholz, N.L. 2011. Landscape ecotoxicology of coho salmon spawner mortality in urban streams. PLoS One, 6(8), p.e23424.

Good, T.P., R.S. Waples and P. Adams (editors). 2005. Updated status of federally listed ESU of West Coast salmon and steelhead. U.S. Department of Commerce, NOAA Technical Memo. NMFS-NWFSC-66. 598 pages.

Gregory, R. S. 1993. Effect of Turbidity on the Predator Avoidance Behaviour of Juvenile Chinook Salmon (*Oncorhynchus tshawytscha*). Canadian Journal of Fisheries and Aquatic Sciences 50(2):241-246.

Hallock, R. J., W. F. Van Woert, and L. Shapovalov. 1961. An Evaluation of Stocking Hatchery-Reared Steelhead Rainbow Trout (*Salmo Gairdnerii Gairdnerii*) in the Sacramento River System. Fish Bulletin No. 114.

Hallock, R. J. and F. W. Fisher. 1985. Status of Winter-Run Chinook Salmon (*Oncorhynchus tshawytscha*) in the Sacramento River. Report. California Department of Fish and Game, Anadromous Fisheries Branch, Sacramento.

Heublein, J. C., R. J. Bellmer, R. D. Chase, P. Doukakis, M. Gingras, D. Hampton, J. A. Israel, Z. J. Jackson, R. C. Johnson, and O. P. Langness. 2017. Life History and Current Monitoring Inventory of San Francisco Estuary Sturgeon. U.S. Department of Commerce, NOAA Technical Memorandum NOAA-TM-NMFS-SWFSC-589, pp.

Johnson, L.E., Ricciardi, A. and Carlton, J.T. 2001. Overland dispersal of aquatic invasive species: a risk assessment of transient recreational boating. Ecological Applications, 11: 1789-1799. https://doi.org/10.1890/1051-0761(2001)011[1789:ODOAIS]2.0.CO;2

Johnson, L. L., T. K. Collier, and J. E. Stein. 2002. An Analysis in Support of Sediment Quality Thresholds for Polycyclic Aromatic Hydrocarbons (PAHs) to Protect Estuarine Fish. Aquatic Conservation: Marine and Freshwater Ecosystems 12(5):517-538.

Kasumyan, A.O. 1994. Olfactory responsivity of sturgeon fishes to free amino-acids. Biophysics 39(3):522–525

Kasumyan, A.O. 1999. Olfaction and taste senses in sturgeon behaviour. J Appl Ichthyol 15(4–5):228–232. https://doi.org/10.1111/j.1439-0426.1999.tb00240.x

Kemp, P., D. Sear, A. Collins, P. Naden, and I. Jones. 2011. The Impacts of Fine Sediment on Riverine Fish. Hydrological Processes 25(11):1800-1821.

Kidd, K. A., M. J. Paterson, M. D. Rennie, C. L. Podemski, D. L. Findlay, P. J. Blanchfield, and K. Liber. 2014. Direct and Indirect Responses of a Freshwater Food Web to a Potent Synthetic Oestrogen. Philos Trans R Soc Lond B Biol Sci 369(1656).

King, K.A., C.E. Grue, J.M. Grassley, R.J. Fisk and L.L. Conquest. 2014. Growth and Survival of Pacific Coho Salmon Smolts Exposed as Juveniles to Pesticides within Urban Streams in Western Washington, USA. Environmental toxicology and chemistry 33(7):1596-1606.

Kogut, N. 2008. Overbite clam, *Corbula amurensis*, defecated alive by white sturgeon, Acipenser transmontanus. Calif Fish Game 94(3):143–149

Laetz, C. A., D. H. Baldwin, T. K. Collier, V. Hebert, J. D. Stark, and N. L. Scholz. 2009. The Synergistics Toxicity of Pesticides Mixtures: Implications for Risk Assessment and the Conservation of Endangered Pacific Salmon. Environmental Health Perspectives 117(3):348-353.

Leitritz, E. and R.C. Lewis. 1980. Trout and Salmon Culture: Hatchery Methods. UCANR Publications.

Lindley, S. T; Schick, R. S; Mora, E.; Adams, P. B; Anderson, J. J; Greene, S., et al. 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(1). http://dx.doi.org/10.15447/sfews.2007v5iss1art4 Retrieved from https://escholarship.org/uc/item/3653x9xc

Lindley, S. 2008. California Salmon in a Changing Climate Presentation. Pages 20 in National Marine Fisheries Service, editor.

Lindley, S.T., C.B. Grimes, M.S. Mohr, W. Peterson, J. Stein, J.T. Anderson, L.W. Botsford, D.L. Bottom, C.A. Busack, T.K. Collier, J. Ferguson, J.C. Garza, A.M. Grover, D.G. Hankin, R.G. Kope, P.W. Lawson, A. Low, R.B. MacFarlane, K. Moore, M. Palmer- Zwahlen, F.B. Schwing, J. Smith, C. Tracy, R. Webb, B.K. Wells and T.H. Williams. 2009. What Caused the Sacramento River Fall Chinook Stock Collapse? NOAA technical memorandum NMFS: NOAA-TM-NMFS-SWFSC-447, https://repository.library.noaa.gov/view/noaa/3664

Lindley, S. T., D. L. Erickson, M. L. Moser, G. Williams, O. P. Langness, B. W. McCovey, M. Belchik, D. Vogel, W. Pinnix, J. T. Kelly, J. C. Heublein, and A. P. Klimley. 2011. Electronic Tagging of Green Sturgeon Reveals Population Structure and Movement among Estuaries. Transactions of the American Fisheries Society 140(1):108-122.

Lindsay, R.B., R.K. Schroeder, K.R. Kenaston, R.N. Toman and M.A. Buckman. 2004. Hooking mortality by anatomical location and its use in estimating mortality of spring Chinook salmon caught and released in a river sport fishery. North American Journal of Fisheries Management 24:367–378.

Linville, R. G., S. N. Luoma, L. Cutter, and G. A. Cutter. 2002. Increased Selenium Threat as a Result of Invasion of the Exotic Bivalve *Potamocorbula amurensis* into the San Francisco Bay-Delta. Aquatic Toxicology 57(1-2):51-64.

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

Martin, C.D., P. D. Gaines and R.R. Johnson. 2001. Estimating the abundance of Sacramento River juvenile winter chinook salmon with comparisons to adult escapement. Red Bluff

Research Pumping Plant Report Series, Volume 5. U. S. Fish and Wildlife Service, Red Bluff, CA.

McClure, M.M. 2011. Climate Change. p. 261-266 In: Ford, M. J. (ed.). Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Pacific Northwest. N. F. S. Center, 281 pp.

McClure, M.M., M. Alexander, D. Borggaard, D. Boughton, L. Crozier, R. Griffis, J.C. Jorgensen, S.T. Lindley, J. Nye, M.J. Rowland and E.E. Seney. 2013. Incorporating climate science in applications of the U.S. Endangered Species Act for aquatic species. Conservation Biology 27(6): 1222-1233.

McCullough, D.A., S. Spalding, D. Sturdevant and M. Hicks. 2001. Summary of technical literature examining the physiological effects of temperature on salmonids. U. S. Environmental Protection Agency, Washington, D. C. EPA-910-D-01-005.

McEwan, D. R. 2001. Central Valley Steelhead. Fish Bulletin 179(1):1-44.

Meyer, J.L., M.J. Sale, P.J. Mulholland and N.L. Poff. 1999. Impacts of climate change on aquatic ecosystem functioning and health. Journal of the American Water Resources Association 35(6): 1373-1386.

Minshall, G.W. 1988. Stream ecosystem theory: a global perspective. Journal of the North American Benthological Society 7(4): 263-288.

Mora, E.A., Battleson, R.D., Lindley, S.T., Thomas, M.J., Bellmer, R., Zarri, L.J., and Klimley, A.P. 2018. Estimating the Annual Spawning Run Size and Population Size of the Southern Distinct Population Segment of Green Sturgeon. Transactions of the American Fisheries Society. 147(1): 195–203.

Moyle, P. B. 2002. Inland Fishes of California, 2nd edition. Berkeley, CA: University of California Press.

Myers, J. M., R. G. Kope, G. J. Bryant, D. Teel, L. J. Lierheimer, T. C. Wainwright, W. S. Grant, F. W. Waknitz, K. Neely, S. T. Lindley, and R. S. Waples. 1998. Status Review of Chinook Salmon from Washington, Idaho, Oregon, and California. NOAA Technical Memorandum NMFS-NWFSC-35.

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

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

National Marine Fisheries Service (NMFS). 2016a. 5-Year Review: Summary and Evaluation of the California Central Valley Steelhead Distinct Population Segment. U.S. Department of Commerce, pp. 43.

National Marine Fisheries Service (NMFS). 2016b. 5-year review: Summary and evaluation of Central Valley spring-run Chinook salmon Evolutionarily Significant Unit. National Marine Fisheries Service. West Coast Region. Central Valley Office, Sacramento, CA.

National Marine Fisheries Service (NMFS). 2016c. 5-year review: Summary and evaluation of Sacramento River winter-run Chinook salmon Evolutionarily Significant Unit. National Marine Fisheries Service. West Coast Region. Central Valley Office, Sacramento, CA.

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

National Marine Fisheries Service (NMFS). 2021. 5-year review: Summary and Evaluation of Southern Distinct Population Segment of the North American Green Sturgeon (*Acipenser medirostris*). National Marine Fisheries Service. West Coast Region. Central Valley Office, Sacramento, CA.

Newcombe, C.P. and D.D. MacDonald. 1991. Effects of suspended sediments on aquatic ecosystems. North American Journal of Fisheries Management 11: 72-82.

Newcombe, C. P. and J. O. T. Jensen. 1996. Channel Suspended Sediment and Fisheries: A Synthesis for Quantitative Assessment of Risk and Impact. North American Journal of Fisheries Management 16(4):693-727.

Paul, M. J. and J. L. Meyer. 2008. Streams in the Urban Landscape. Pages 207-231 in Urban Ecology. Springer.

Platts, W.S., M.A. Shirazi and D.H. Lewis. 1979. Sediment particle sizes used by salmon for spawning, and methods for evaluation. EPA-600/3-79-043, 32 pp. Corvallis Environ. Res. Lab., Corvallis, Oregon.

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.

PFMC. 2023. Preseason Report III: Council Adopted Management Measures and Environmental Assessment Part 3 for 2023 Ocean Salmon Fishery Regulations: BL66. Pacific Fishery Management Council

Phillips, R. W. and H. J. Campbell. 1961. The Embryonic Survival of Coho Salmon and Steelhead Trout as Influenced by Some Environmental Conditions in Gravel Beds. Pages 60-72 in Fourteenth Annual Report. Pacific Marine Fisheries Commission, Portland, Oregon.

Poytress, W.R., J.J. Gruber, C.E. Praetorius, and J.P. Van Eenennaam. 2013. 2012 Upper Sacramento River Green Sturgeon Spawning Habitat and Young-of-the-Year 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, F.D. Carrillo and S.D. Voss. 2014. Compendium Report of Red Bluff Diversion Dam Rotary Trap Juvenile Anadromous Fish Production Indices for Years 2002-2012. Report of U.S. Fish and Wildlife Service to California Department of Fish and Wildlife and US Bureau of Reclamation.

Poytress, W.R., J.J. Gruber, J.P. Van Eenennaam and M. Gard. 2015. Spatial and Temporal Distribution of Spawning Events and Habitat Characteristics of Sacramento River Green Sturgeon. Transactions of the American Fisheries Society 144(6):1129-1142.

Presser, T. S. and S. N. Luoma. 2010. A Methodology for Ecosystem-Scale Modeling of Selenium. Integrated Environmental Assessment and Management 6(4):685-710.

Presser, T. S. and S. N. Luoma. 2013. Ecosystem-Scale Selenium Model for the San Francisco Bay-Delta Regional Ecosystem Restoration Implementation Plan. San Francisco Estuary and Watershed Science 11(1):1-39

Pusey, B. J. and A. H. Arthington. 2003. Importance of the Riparian Zone to the Conservation and Management of Freshwater Fish: A Review. Marine and Freshwater Research 54(1):1-16.

Reclamation (U.S. Bureau of Reclamation). 2008. Biological Assessment on the Continued Long-Term Operations of the Central Valley Project and the State Water Project. Department of the Interior, pp. 64.

Red Bluff Fish and Wildlife Office (RBFWO). 2023. US Fish and Wildlife Services. Bill Poytress, Program Manager, RBFWO. Personal Communication on June 2 and November 9, 2023.

Roberts, B.C. and R.G. White. 1992. Effects of Angler Wading on Survival of Trout Eggs and Pre-Emergent Fry. North American Journal of Fisheries Management 12(3):450-459.

Roos, M. 1987. Possible Changes in California Snowmelt Patterns. Proc., 4th Pacific Climate Workshop, Pacific Grove, California, 22–31.

Roos, M. 1991. A Trend of Decreasing Snowmelt Runoff in Northern California. Proc., 59th Western Snow Conference, Juneau, Alaska, 29–36.

Sacramento River Advisory Council. 2003. Sacramento River Conservation Area Forum (SRCAF) Handbook. Red Bluff, CA.

Scott, G. R. and K. A. Sloman. 2004. The Effects of Environmental Pollutants on Complex Fish Behaviour: Integrating Behavioural and Physiological Indicators of Toxicity. Aquatic Toxicology 68(4):369-392.

Schlosser, I. J. and J. R. Karr. 1981. Riparian Vegetation and Channel Morphology Impact on Spatial Patterns of Water Quality in Agricultural Watersheds. Environmental Management 5(3):233-243.

Scriven, C., J. Sweeney, K. Sellheim and J. Merz. 2018. Lower American River monitoring, 2018 steelhead (*Oncorhynchus mykiss*) spawning and stranding surveys. Central Valley Project, American River, California, Mid-Pacific Region. Cramer Fish Sciences, Sacramento, California.

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(7):1389-1395.

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

Snider, B., B. Reavis, and S. Hill. 2001. 2000 Upper Sacramento River winter-run chinook salmon escapement survey. California Department of Fish and Game, Stream Evaluation Program, Habitat Conservation Division Stream Evaluation Technical Report 01-1.

Southwest Fisheries Science Center (SWFSC). 2022. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. 11 July 2022 Report to National Marine Fisheries Service – West Coast Region from Southwest Fisheries Science Center, Fisheries Ecology Division 110 McAllister Way, Santa Cruz, California 95060.

Steel, A. E., M. J. Thomas, and A. P. Klimley. 2018. Reach Specific Use of Spawning Habitat by Adult Green Sturgeon (*Acipenser medirostris*) under Different Operation Schedules at Red Bluff Diversion Dam. Journal of Applied Ichthyology 35(1):22-29.

Thomas, M.J., Peterson, M.L., Chapman, E.D. et al. 2019. Individual habitat use and behavior of acoustically-tagged juvenile green sturgeon in the Sacramento-San Joaquin Delta. Environ Biol Fish 102, 1025–1037 (2019). https://doi.org/10.1007/s10641-019-00888-1

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(5):465-478.

Tucker, M. E., C. M. Williams, and R. R. Johnson. 1998. Abundance, Food Habits, and Life History Aspects of Sacramento Squawfish and Striped Bass at the Red Bluff Diversion Complex, California, 1994-1996. U.S. Fish and Wildlife Service, Report Series: Volume 4, pp.

USDA FS 2012. National Best Management Practices for water quality management on National Forest Service lands. Volume 1: National Core BMP technical guide.

VanRheenen, N. T., A. W. Wood, R. N. Palmer, and D. P. Lettenmaier. 2004. Potential Implications of Pcm Climate Change Scenarios for Sacramento-San Joaquin River Basin Hydrology and Water Resources. Climatic Change 62(62):257-281.

Vogel, D. A. and K. R. Marine. 1991. Guide to Upper Sacramento River Chinook Salmon Life History. U.S. Bureau of Reclamation Central Valley Project. Redding, CA: CH2M Hill.

Wade, A.A., T.J. Beechie, E. Fleishman, N.J. Mantua, H. Wu, J.S. Kimball, D.M. Stoms and J.A. Stanford. 2013. Steelhead vulnerability to climate change in the Pacific Northwest. Journal of Applied Ecology 50(5):1093-1104.

Webb PW. 1986. Kinematics of lake sturgeon, *Acipenser fulvescens*, at cruising speeds. Can J Zool 64(10):2137–2141. https://doi.org/10.1139/z86-328

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(3):416.

Williams, T. H., S. T. Lindley, B. C. Spence, and D. A. Boughton. 2011. Status Review Update for Pacific Salmon and Steelhead Listed under the Endangered Species Act: Update to January 5, 2011 Report., National Marine Fisheries Service, Southwest Fisheries Science Center. Santa Cruz, CA.

Williams, T.H., B.C. Spence, D.A. Boughton, R.C. Johnson, L.G. Crozier, N.J. Mantua, M.R. O'Farrell, and S.T. Lindley. 2016. Viability assessment for Pacific salmon and steelhead listed under the Endangered Species Act: Southwest. U.S. Department of Commerce, NOAA Technical Memorandum NMFS-SWFSC-564.

Wright, S. A. and D. H. Schoellhamer. 2004. Trends in the Sediment Yield of the Sacramento River, California, 1957 – 2001. San Francisco Estuary and Watershed Science 2(2).

Wyman MT, Thomas MJ, McDonald RR, Hearn AR, Battleson RD, Chapman ED, Kinzel P, Minear JT, Mora EA, Nelson JM, Pagel MD, Klimley AP. 2018. Fine-scale habitat selection

of green sturgeon (*Acipenser medirostris*) within three spawning locations in the Sacramento River, California. Can J Fish Aquat Sci 75:779–791. https://doi.org/10.1139/cjfas-2017-0072

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

Yoshiyama, R. M., F. W. Fisher, and P. B. Moyle. 1998. Historical Abundance and Decline of Chinook Salmon in the Central Valley Region of California. North American Journal of Fisheries Management 18(3):487-521.